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Methodological Issues in Valuing Grazing and Range Uses of National Forests and Grasslands

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Methodological Issues in Valuing Grazing and Range Uses of National Forests and Grasslands

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Introduction

The Forest Service is required periodically to develop a strategic plan. The current plan, the USDA Forest Service Strategic Plan (2000 Revision), was developed following the requirements of the Government Performance and Results Act (GPRA) of 1993. GPRA instructed federal agencies to increase their emphasis on strategic planning with an improved linkage between planning and performance. Previously, the Forest Service developed the strategic plan following the requirements of the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA). The Strategic Plan incorporates many of the legal requirements previously covered in the RPA Program, including an economic analysis of the outputs from the National Forest System (which is composed of the national forests and grasslands).

The economic analysis component of the Strategic Plan describes the resource outputs of national forests and grasslands (timber, minerals, range forage, water, and recreation) over time and the benefits those outputs deliver to the people of the U.S. Included in this analysis are estimates of the economic benefits from national forests. The resource values developed for the economic analysis in the Strategic Plan are often used in economic analyses for forest planning and project analysis.

Two accounting stances were considered in the 2000 Strategic Plan. One is a cash flow analysis, based on receipts generated from outputs of the National Forest System. The other is a broader notion of the benefits received by forest users from management of the national forests and grasslands, regardless of the extent to which those values generated actual receipts. In the Strategic Plan analysis, this second accounting was presented as a willingness-to-pay for Forest Service outputs. We will

refer to it as total use value. It is a use value in the sense that it is measured as the willingness to pay of direct "on the ground" users of the resource outputs. It does not attempt to measure benefits that accrue to secondary or other users.

Measuring receipts, or gross revenues, is a straightforward accounting exercise. Existing user fees are known and receipts from timber sales, grazing, recreation uses, and revenues from other Forest Service outputs can be summed to provide an accurate portrayal of receipts.

A less straightforward issue is how to measure the broader notion of total use value received. Conceptually, this corresponds to the total area under the demand curve for the Forest Service output (timber, access to recreation, rights to graze, etc.). In a case where the value of output from national forests is provided by a perfectly competitive market, market price measures benefits at the margin. In cases where the outputs are not traded in competitive markets—more specifically, when goods are not rationed strictly by price--the notion of consumer surplus enters the measure of total use value (Mumy and Hanke 1975; Hof and Loomis 1986).

In this paper we focus on the broadly conceived notion of total use value. Further, we focus our discussion on methods for valuing uses of National Forest System lands that are managed under grazing permits for domestic livestock use. The ideas and procedures developed may be appropriate for other federal and state lands including those administered by the Bureau of Land Management (BLM) and state land offices.

Rangelands

The Society for Range Management defines rangelands as "land on which the indigenous vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and is

managed as a natural ecosystem" (Glossary Update Task Group 1998). The total area of rangelands in the United States is not tabulated directly, but is reported as rangelands and/or grazing lands, depending on the agency maintaining the records and the time at which the records are tabulated (Mitchell 2000). Grazing lands are lands that are grazed or have the potential to be grazed and include rangelands, pastures, grazed woodlands, and grazed croplands. Grazing lands occupy 801 million acres of the United States or approximately 42 percent of the continental United States (Mitchell 2000). The total non-federal grazing land in the United States was 587 million acres in 1992. Total rangelands on National Forest System lands were estimated by Mitchell (2000) to be approximately 75 million acres. He also classified 95 percent, or 155.4 million acres, of public lands administered by the Bureau of Land Management outside of Alaska as rangelands.

Private Grazing on Public Land

A fundamental problem of assessing private grazing on public lands is to determine an equitable value, or otherwise estimate the level of benefits conveyed to private users of public lands. One could conceive of range forage on public land as being much like its private sector counterpart. Under private ownership, a forage market exists and competition between grazing users drives the price to a market-clearing level. At this equilibrium price, forage supply and forage demand are equal, and a market price is determined. In the specific case of users competing to obtain access to a particular piece of grazing land, market price captures the benefit received by the user. In general, that market price may or may not reflect the total use value of forage being used by any particular user.

An equitable price or fee[1] for forage has been defined in various ways. Brokken and McCarl (1987) define an equitable fee to be one that is fair, impartial, and gives justice in the distribution of net social benefits. A competitive market is said to determine an equitable price (Gardner 1962, Brokken and McCarl 1987), and comparisons to the competitive private forage market have provided the historic basis for analyzing grazing fees and forage values on public lands. Historical justification for various forage valuation procedures has been based on the theoretical premise that ranchers maximize profit. Private forage, an intermediate good, has a derived demand in the production of livestock, and the forces of supply and demand operate to establish forage prices within a competitive market (Jensen and Thomas 1967).

Value of Range Use

Productive use of rangelands is not limited to grazing by domestic livestock. Rangelands are sites for recreational use, water production, and wildlife habitat. They are home to many rare plant and animal species. The uses and values associated with rangelands are varied and could include those associated with all wildlands and open space.

In past work, the value of rangeland forage has been based on its use in the production of livestock products by the private sector. Amenity values associated with grazing and using rangelands have been largely ignored. The numerous instances where

[1]There is a distinction to be made between prices determined in a competitive market and fees charged by public agencies. Fees on public lands are generally set administratively, and the extent to which they are based on the notion of collecting fair market value varies by agency and by resource. Grazing fees are separate from resource value, and can be set at, above (in theory anyway), or below the level of benefits actually received by the fee payer. Setting the fee at the level of benefits received implies that the recipient pays for full value received. Setting the fee below the level of benefits received implies added benefits accruing to users of that particular resource.

researchers have estimated forage values in excess of livestock production value, and have examined the expressed desires of ranchers, emphasize that livestock production is not the only reason rural families are involved with the range livestock business (Tanaka and Gentner 2001, Liffman et al. 2000, Rowe et al. 2001). Ranchers rate lifestyle reasons for ranching above the traditional economic objective of maximizing net income from livestock production.

The resource output of the National Forest System is access to rangeland, but the research cited above indicates that benefit is derived from more than forage. This implies that ranchers apparent willingness to pay for access to public land for grazing may not be tied solely to a specific level of grazing use. Just the fact that a rancher is given access to a piece of public land might convey some value.

We approach the valuation of rangeland forage from the basis of total value to resource users. This includes the value added in livestock production and other values associated with rangelands and ranching that we have grouped as quality-of-life (QOL) values. Users of rangeland forage are assumed to satisfice (i.e., maximize their satisfaction from the use of rangelands for all purposes). Our analysis is different from previous research in that prior work dealt only with the value of forage for livestock production.

Much of the prior work has dealt with determining the appropriate grazing fee for public rangeland grazing. The key issue regarding grazing fees is determining the level of economic benefits received by users of public rangelands. The best estimate of those benefits was thought to be a comparison to private rangeland lease rates. In actuality, fees or lease rates may or may not reflect the total benefit received from use of the range

output of national forests (see footnote 1). Hence, the focus of this paper goes beyond the grazing fee issue.

Past Efforts in Valuing Forest Service Forage

The Resource Planning Act of 1974 (RPA) directed the Forest Service to prepare an assessment of the Nation's renewable resources every 10 years and to develop a program for renewable resource management every 5 years. The assessment includes the analysis of present and future uses, which includes the pertinent supply, demand, and price relationship trends. The RPA Program included valuation of benefits resulting from the preferred management alternative. In the 1980 RPA Program, range values were estimated using a proxy measure of market value based on an alternate feed source, specifically the price of hay based on Henderson (1965) and updated to 1980 price levels.

In the 1985 RPA Program, range values were estimated using average lease rates negotiated for grazing on private lands, with a downward adjustment of five percent to reflect differences in the terms and conditions generally attached to federal permits as compared with private leases (Tittman and Brownell 1984). Data on private land lease rates came from studies done in response to the Public Rangelands Improvement Act of 1978 (PRIA), the purpose of which were to provide the basis for a grazing fee for 1986 and beyond. The value estimates represented an average appraised market value per AUM.[2]

Resource outputs were valued using three accounting stances in the 1990 RPA Program and the Draft 1995 RPA Program (1995 never had a final Program): receipts,

[2] An Animal Unit Month (AUM) is defined as the amount of forage required by a 1,000 pound cow, or the equivalent, for one month.

market clearing prices, and willingness to pay values. Receipts were based on collection of fees from grazing permittees. Market clearing prices were based on estimates from the 1983 market appraisal study to estimate "fair market value" of grazing access to national forests and grasslands. The intent of the fair market value appraisal was to learn how private markets would value grazing on national forests and grasslands. Estimates from the appraisal study were updated to 1989 values using the Forage Value Index that is based on the private grazing land lease rate from the National Agricultural Statistics Service (USDA/USDI 1986).

Willingness to pay values were based on a study by Hahn et al. (1989). Using a cost of production approach, Gee (1981) developed a series of ranch budgets representing up to four ranch sizes for each national forest where grazing was occurring. Hahn et al. (1989) updated these budgets for changes in price levels and aggregated them into regional budgets, corresponding to Forest Service regions. The authors then used linear programming (LP) techniques to estimate the additional income that would be gained from one more unit of Forest Service grazing, i.e., the value of the marginal product. More will be said about the LP approach in a later section of this paper (see p. 31). All earlier RPA valuations of range forage relied upon or suggested that forage value accrued to private users because of potential revenue from livestock production.

Previously estimated RPA values relied on the suggestion that value of the grazing/forage output of the national forests accrued from livestock production. As will be detailed in a later section, several recent empirical studies and historical ranch budgeting and ranch value studies by Martin and Jeffries (1966) call this assumption into question.

Scope of this Study

Our purpose in conducting this study is to review methods of estimating value and to determine appropriate methods of valuing forage and the broader values of rangeland use that go beyond its value for forage/livestock production. The QOL factors are not about forage or grazing per se, although for ranchers one aspect of the QOL might be the ability to maintain a ranch operation and lifestyle. We recognize there are many values associated with rangelands, including livestock production, open spaces, economic opportunities for rural people, and quality-of-life attributes (USDA 1998). Even limiting the scope of the paper to rangeland forage and its use requires a rethinking of the benefits that are obtained from grazing and using public rangeland. Rangeland values will be of primary use to the Forest Service in Strategic Planning and other analyses of National Forest System outputs.

Theoretical Basis for Valuing Public Land Forage

The theoretical justification for various forage valuation procedures has been based historically on the premise that ranchers maximize profit. Forage has a derived demand in the production of livestock, and the forces of supply and demand operate to establish forage prices within a competitive market (Jensen and Thomas 1967). The standard economic model of production and optimal input use implies certain behavioral postulates and requires certain conditions for validity. Observation has shown shortcomings in using the "theory of the firm" to explain the behavior of livestock producers in leasing forage. Most notably, the value of private and public land grazing does not appear to arise strictly from livestock-producing potential (Martin and Jeffries

1966). Ranchers have motives beyond profit that influence their willingness to pay for forage, buy ranches, and remain in business when other investments would provide a higher rate of investment return (Torell et al. 2001).

Recognizing that both livestock production and quality of life (QOL) are important motives for ranching, we first describe the traditional economic model of derived demand and the theory of the firm. We then present a discussion of values arising from amenities associated with quality of life. Forage valuation methods based on livestock production and livestock income are reviewed. We then discuss valuation methods that can include QOL values.

Valuing Forage for Agricultural Production

Establishing the value of public land forage based on its value for livestock production has a long history with strong ties to the standard production economic model describing optimal input use by a profit-maximizing firm. These production principles were first highlighted in an economic model developed as part of grazing fee research conducted in Utah (Roberts 1963). This model formed the traditional basis for valuing forage on public lands (Jensen and Thomas 1967, Nielsen and Wennergren 1970, Brokken and McCarl 1987, Bartlett et al. 1993).

As shown by Roberts (1963), Nielsen and Wennergren (1970), and Brokken and McCarl (1987), the Utah forage value model implies the standard condition for profit maximization. Profit maximizing firms are theorized to use inputs to the point where the marginal contribution of each factor in producing revenue, i.e., the value of the marginal product of factor i (VMP_i), is equal to the marginal factor cost of input i (MFC_i). VMP_i is composed of 1) marginal physical product (MPP_i), which is the marginal (added)

productivity of factor i when used to produce livestock, and 2) the marginal revenue from selling the product, which with perfect competition is the price of the product. Under this construct, resources are valued for their marginal physical productivity and the present and anticipated price of the livestock product to be sold.

The MPP of a resource depends on the quantities of other inputs used.[3] With multiple inputs, factor demand is a function of the prices of the factor considered (range forage), the prices of all other variable factors of production, the price of the livestock output, and the quantities of any fixed factors (Brokken and McCarl 1987). Thus, if the relative prices of some inputs change, the efficient (profit-maximizing) combination of inputs may also change.

By adjusting stocking rates to the level where VMP is equal to MFC, a profit-maximizing level of input use and output is determined. However, the profit maximizing level of public range forage use might exceed the limit imposed by the land management agencies. Roberts (1963) demonstrates that if the profit-maximizing rancher must set forage harvest where VMP exceeds MFC, an excess value accrues to the permittee. With a long-term lease this excess value would be capitalized into a permit value, i.e., the base property of the ranch. Thus arises the traditional theory of why public land grazing permits have market value, and the widespread belief that the existence of permit value suggests public land forage is under-priced.

Valuing Forage for Quality-of-Life Reasons

[3] Roberts (1963) presented his analysis of public land grazing fees using the VMP and factor demand concepts, assuming a single factor of production. He used the standard assumptions about perfect competition in the input and output markets and assumed declining marginal physical product from the range forage input. Brokken and McCarl (1987) generalized the analysis to multiple inputs, but the qualitative results and implications remain unchanged.

Buying ranches or leasing forage to obtain the associated lifestyle, as well as the revenue that accrues from agricultural production, suggests an economic model based on the household production function (Silberberg 1990, Deaton and Muellbauer 1980). Based on work by Becker (1965) and Lancaster (1966a, b), household producers combine inputs of goods and services with time and human capital to produce an output, in this case QOL. Relating this model to ranching, ranchers are thought to realize satisfaction and utility from recreation and cultural experiences, open spaces, and scenic views associated with the ranching lifestyle. They maximize utility, of which profit is one component, subject to a budget constraint. Ranching as a way-of-life is a good that provides utility and satisfaction to the ranch owner and family. Further, amenities like wildlife, timber, streams and lakes, or close access to these amenities on public lands, may offer additional income earning opportunities.

There are at least three indicators that ranchers are not motivated primarily by profit from livestock production. First, returns to both private and public land ranches are low by any standard measure of investment performance. Depending on ranch size, nominal rates of return from livestock production have typically been reported to range from negative amounts to about 3%, averaging no more than 2% (McGrann 2000, Torell et al. 2001, Smathers et al. 1998b, Workman 1986). This is considerably less than the 5 to 9% rate of return that the American Agricultural Economics Association (AAEA) estimates farmers and ranchers could make on alternative non-agricultural investments of similar risk (AAEA 1998).

A second indicator that ranchers do not adhere to a strong profit motive is the relatively small part of land value explained by livestock production value. Trends in

ranchland values seem to be impervious to the price of beef and net livestock returns. Wildlife enterprises, timber harvest, oil and gas, and others offer additional revenue potential on western ranches. These other profit opportunities have been shown to affect ranch value (Pope 1985).

Adkins and Graeber (1978) found that the productive value of ranches in the Hill Country of Texas accounted for about 10% of ranchland market value, but in the High Plains, productive value accounted for nearly 50% of market value. Similarly, Pope (1985) found population density, aesthetic differences, quality of deer hunting, and proximity to major metropolitan centers explained most differences in Texas land values. While net annual production returns were statistically significant and were an important determinant of rural land values, earning potential explained only 22% of the market value of Texas agricultural lands. Torell and Bailey (2000) found no statistical relationship between variation in net annual livestock returns or variation in beef prices and the recent trend in New Mexico ranchland values. Important determinants of land value in all areas included the level of dependency on public lands for grazing capacity, distance to a trade center or large town, and proximity of the ranch to scenic mountain areas. The land value influence of quality-of-life factors has continued if not accelerated in recent year. In an assessment of agricultural land values in the various Federal Reserve Districts, Barkema and Novack (2000, p. 39) note that as compared to other U.S. agricultural areas, "Ranchland values in the mountain states climbed the most, influenced more by nonfarm investors' demand for scenic mountain views than by ranchers' demand for additional grazing land."

The third indicator that profit is of secondary importance is that western ranchers list quality of life as the primary reason for land purchase. Martin and Jeffries (1966) recognized this over 30 years ago. Numerous authors reviewed indicators that western ranchers are not motivated primarily by profit (Martin 1966, Martin and Jeffries 1966, Smith and Martin 1972, Harper and Eastman 1980, Biswas et al. 1984, Sullivan and Libbin 1987, Bartlett et al. 1989, Young and Shumway 1991, Gentner 1999, Liffman et al. 2000, Rowe et al. 2001, Torell et al. 2001, Tanaka and Gentner 2001). These studies show, for most agricultural producers, the desirable quality-of-life (QOL) attributes associated with rural living are more important goals than profit maximization.

To help define social and economic characteristics of western public land ranchers, Gentner (1999) conducted a mail survey of Bureau of Land Management (BLM) and U.S. Forest Service (USFS) permittees. Using cluster analysis, western public land ranchers were grouped as either hobbyists (50.5%) or professional ranchers (49.5%)[4]. By definition, professional ranchers derived more than half of their income from on-ranch sources (Tanaka and Gentner 2001). Under the hobbyist/professional dichotomy, eight subgroups emerged with various socioeconomic factors used as clustering variables (Table 1 and Fig. 1). The goals and objectives of public land ranchers varied from a high ranking for QOL factors, especially for identified hobby ranchers, to a strong emphasis on profit maximization for professional ranchers more dependent on ranch income.

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[4]The terms "Hobbyist" and "Professional" refer to the broad categorizations used by Gentner (1999) and Tanaka and Gentner (2001) to relate the level of dependence on the ranch for family income. Many part-time ranchers take exception to the term "Hobbyist" because they consider the ranch to be their livelihood and work off the ranch to continue in the livestock business. Consider these terms general acronyms used for categorization.

Gentner (1999) found all types of public land ranchers ranked QOL factors above profit maximization. This suggests "all ranchers are economic satisficers with varying degrees of importance placed on earning potential from the ranch" (Gentner 1999, p. 49). All ranch groups listed the complementary relationship between land ownership and family tradition, culture, and values as a primary reason for owning the ranch. The relative importance of profit has varied from study to study, and multiple and inter-related goals are involved.

Significant policy implications arise when the primary reason for ranch ownership and livestock production is not profit (from the livestock operation). As noted by Torell et al. (2001), when ranch market values are driven by non-profit factors, disparities will exist between the livestock production value and the market value of forage; and traditional profit-driven economic models used to evaluate land-use policy will be inadequate.

Methods of Valuing Forage

Market Price Comparison

Comparison to the private forage market is based on the alternative cost doctrine whereby a rational lessee of forage will not pay in excess of the amount that must be paid for the next best alternative for forage. If private and public forages are perfect substitutes, economically motivated ranchers should be willing to pay equal amounts for the two sources of forage. Competition for leased forage will supposedly drive lease

Table 1. Description of cluster analysis groupings of public land ranchers as reported by Gentner (1999).

Cluster Group		Description	Annual Taxable Income ($)[a]	Percent Ranch Income[b]
Professional -	Diversified Family Rancher	Diversified ranch producing various agricultural commodities, motivated by profit.	42,970	75
Professional -	Dependent Family Rancher	Highest dependence on ranch income, feel strongly about ranching as a way of life, perceived low job mobility.	46,926	85
Professional -	Corporate Rancher	Business structured as a corporation, dependent on hired labor, profit motivated.	50,116	72
Professional -	Sheep Rancher	Produce primarily sheep with large herds, highly dependent on ranch income and on hired labor. Highly dependent on public lands.	53,000	81
Hobbyist -	Small Hobbyist	Most income from off-ranch jobs, not motivated by profit. Many with college degrees. More diversified income with more retirement and investment income than working hobbyists.	65,857	13
Hobbyist -	Retired Hobbyist	Primarily retired ranchers, high dependency on ranching and agricuture for income when compared to other hobbyists.	44,602	22
Hobbyist -	Working Hobbyist	Most income from off-ranch jobs. Highly educated with smallest herd size and deeded acreage.	53,491	18
Hobbyist -	Trophy Rancher	Large ranches, use hired labor, highly educated, wealth made elsewhere.	94,245	21

[a]/Annual taxable income from on and off the ranch.

[b]/Percent of annual taxable income from the ranch.

Survey results are estimated to be valid within the range of +/- 3%.

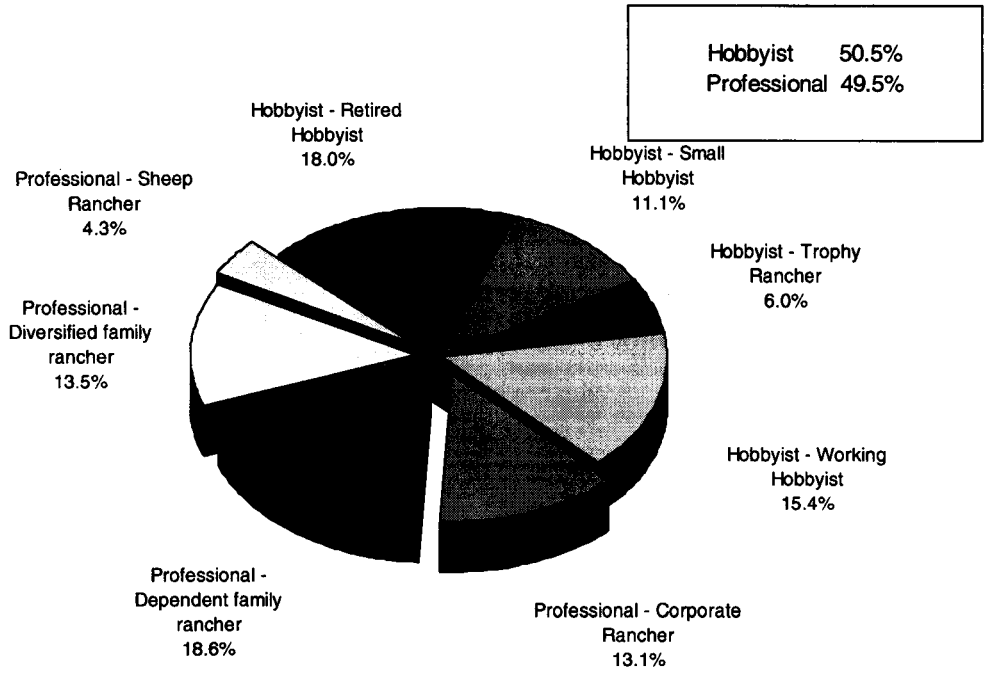
Hobbyist 50.5%
Professional 49.5%
Hobbyist - Retired Hobbyist 18.0%
Hobbyist - Small Hobbyist 11.1%
Professional - Sheep Rancher 4.3%
Hobbyist - Trophy Rancher 6.0%
Professional - Diversified family rancher 13.5%
Hobbyist - Working Hobbyist 15.4%
Professional - Dependent family rancher 18.6%
Professional - Corporate Rancher 13.1%

Figure 1. Cluster analysis grouping of public land ranchers as reported by Gentner (1999).

prices to the value of the marginal product in producing livestock. Because public grazing permits provide for renewal to the current holder, there is no competition to determine value. Consequently, it has been accepted that the fair market value would have to be estimated indirectly by comparing to the private forage market (USDI/USDA 1977).

Nearly all valuations of public land forage have used the private forage market to imply a value for public land forage. These comparisons date back to 1916 when the U.S. Forest Service used the rental value of some 900 tracts of private land to determine the apparent market value of Forest Service forage (Dutton 1953). Federal grazing fee studies have continued to rely on private forage market price comparisons as one of the

primary indicators of market value (Rachford 1924; USDA/USDI 1986, 1992; USDI/USDA 1977, 1993, 1994).

When tracts of land have comparable characteristics, it is widely believed that comparison to the private forage market is valid, but adjustments must be made to account for differences in non-fee grazing costs and leasehold arrangements. This validity depends on the assumption of perfect competition. Kearl (1989) questioned this assumption given the observation that, in many areas of the West, there are relatively few sellers of forage. He felt the forage market was characterized by monopolistic competition with price discrimination.

Private landowners often provide services to grazing tenants that are not provided on public lands, including fencing investment and maintenance; water access, facilities, maintenance and upkeep; periodic checking, moving and supplemental feeding of livestock; exclusion of access to the grazing tract by individuals other than the grazing tenant and landowner; and hunting, fishing and timber-harvest rights (LaFrance and Watts 1995). These rights and services have value to the lessee that is incorporated into the private land lease rate.

Many comparisons to the private forage market have failed to adequately adjust for lessor-provided services and to recognize other lease and land-tract differences. Some of the earliest grazing fee studies did adequately adjust for lease differences. The Rachford (1924) appraisal and lease rate comparison, for example, compared 1,675 private land tracts (16.2 million acres) to some ten thousand USFS allotments that had been rated for compatibility based on forage availability, distance to water, topography, and accessibility. When the appraisal results and comparison were presented at public

meetings, there was widespread agreement about the fairness of the comparison method, but as a business proposition, public land ranchers were unanimous in opposing the fee increases proposed at the time (Dutton 1953). By comparison, the 1986 grazing fee report and mass appraisal of forage (USDA/USDI 1986) was severely criticized by western university economists and others for the minimal adjustments (5% for conditions of use and 10% for lease prepayment) that were made between private and public leased lands, and the mass appraisal procedures used (Dudley and Rostvold 1992, Kearl 1989, USDA/USDI 1992).

Attempts have been made to statistically determine how private land lease rates vary when selected services are provided or not provided with forage leases. These studies have generally used regression procedures on a cross-section of private land lease rate observations to estimate service and forage values (Gray et al. 1983, Fowler et al. 1985, Torell et al. 1988, Torell and Bledsoe 1990, Rimbey et al. 1992, Rimbey et al. 1994). Because lessor services tend to be provided in blocks (i.e., many types of services are provided or no services are provided by the lessor), these regression studies had problems with multicollinearity. Consequently, principal components regression was used to estimate service values in Fowler et al. (1985), and more broadly grouped categories of services were used in the other studies. Other studies considered the value of landlord-provided services for daily care of livestock, watering livestock, maintenance of fences and facilities, and grazing access to the leased property. They did not value the hunting, fishing and timber-harvest rights, exclusion of access to outside parties, differences in stewardship requirements, and prepayment of the public lease.

Results of six New Mexico lease rate studies, conducted primarily to evaluate the market value of New Mexico state trust lands, were summarized in Appendix A of Torell and Fowler (1992). These studies consistently found the value of landlord services to comprise about 30% of the average lease price. Rimbey et al. (1992) found a slightly higher percentage in Idaho, but this included an adjustment for prepayment of the lease that was not considered in the New Mexico studies. The Idaho study found the value of services to average 36% or 39% of the average lease price, depending on whether the National Agricultural Statistics Service (NASS) survey lease rate or a University of Idaho survey rate was used.

Using the 30% average service valuation in their calculations, LaFrance and Watts (1995) estimated the average composite real rate of return on private grazing lands was 3.37%. They noted that this value was nearly identical to the 3.35% rate estimated from New Mexico ranch sales by Torell and Doll (1991), and concluded that the 30% average service valuation was appropriate across all eleven western states.

LaFrance and Watts (1995) concluded an appropriate way to value public land forage was to multiply the NASS reported lease rate by 70% (to account for a 30% service value allowance), and also considered a second option of subtracting the $2.10/AUM service value estimated by Torell et al. (1988) (updated to 1992 dollars). Both procedures gave similar value estimates.

As part of the 1992 Incentive Based Grazing Fee study, Rimbey et al. (1994) estimated not only the value of lessor services but also how total grazing costs to the lessee varied when selected services were or were not provided by the lessor. Using 134 private land leases in Idaho, New Mexico and Wyoming, Rimbey et al. (1994) estimated

care of livestock and providing water by the lessor, added $3.83/AUM to the lease price, relative to those leases where these services were not provided. By comparison, non-fee grazing costs to the lessee were reduced by $7.49/AUM. They suggested that the disparity in value could be explained by the location advantage of the lessor. The lessor can provide these services cheaper because they generally live at or near the lease.

As noted above, comparing to the private forage market has historically assumed the market lease rate reflects the value of forage for livestock production. Yet, the market price comparison method does not necessarily give the value of the forage for livestock production alone. While ranchers theoretically estimate their willingness to pay based on livestock earning potential and the profit maximizing model, the actual price paid can be for a combination of reasons. As noted by Martin and Jeffries (1966, p.239), private land lessors of forage also pay too much relative to livestock earnings potential and concluded "Evidently private lands are not rented merely for the purpose of profits from beef production either". Recent cost and return studies confirm this willingness to pay too much for private leased forage has continued (Torell et al. 2000, Smathers et al. 1998a). Leasing private lands provides those who cannot afford to buy ranches the opportunity for livestock income and QOL experiences.

Total Cost Approach

The total cost approach is another form of market price comparison that assumes that the forces of supply and demand interact in a competitive market to establish equitable prices for forage. This valuation approach is based on the belief that "the fair market value of public range forage used for grazing is equal to the lease rate for private forage adjusted by the amount that the cost of grazing on private lands is less than the

cost of grazing on public lands" (USDI/USDA 1977, p. 2-19). A comparison of total fee and non-fee grazing costs on private and public lands are used to estimate forage value on public lands that would make total grazing costs between the two land types equal. The total cost approach explicitly recognizes differences in non-fee grazing costs between private and public lands, whereas these differences are not explicitly recognized when using only private land lease rates to imply the value of public land forage. The approach has been criticized for relying on ranchers as the source of information for the cost comparison.

The total cost approach was used to derive the $1.23/AUM base rate used in the current PRIA fee formula[5] (USDI/USDA 1977). Total fee and non-fee costs of grazing private and public rangelands were compared using data collected in a 1966 Western Livestock Grazing Survey. The estimated $1.23/AUM difference in total grazing costs was considered to be the value of public land forage and the grazing fee that should have been charged in 1966 (USDI/USDA 1977). A major point of controversy was excluding interest on the permit investment as a cost item in calculating the base value.

The 1992 Incentive Based Grazing Fee Study (Bartlett et al. 1993) also used the total cost approach as a forage valuation alternative. In this study, the Grazing Fee Task Group (GFTG) started with the perception that the total cost approach would give an appropriate valuation of public land forage. The conclusion was that for total grazing costs to be equal on private and public lands, the public land grazing fee would have to be reduced from the 1992 level of $1.92/AUM to $0.13/AUM. Cost differences were found

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[5] The PRIA fee formula is calculated as: $FEE_t = \$1.23\ X\ (FVI_{(t-1)} + BCPI_{(t-1)} - PPI_{(t-1)})/100$, where FVI is the Forage Value Index, BCPI is the Beef Cattle Price Index, and PPI is the Prices Paid Index, all maintained by USDA Economic Research Service. The PRIA formula with modification by Executive Order in 1986 is still used to set public land grazing fees.

between USFS and BLM permits and between cattle and sheep producers. When permit types were separated, cattle producers paid $3.63/AUM less for BLM forage versus private leases, but $2.86/AUM more for USFS forage. Sheep producers paid $2.77/AUM more for BLM forage and $12.22/AUM more for USFS forage than for private forage. These values suggest, even without a grazing fee, sheep producers on both BLM and USFS lands, and cattle producers on USFS lands were paying more on average than those with private leases because of higher non-fee grazing costs. Including an interest charge on the permit investment would have resulted in an even greater disparity.

These study results are not consistent with the profit-maximizing model, which suggests that livestock producers would not pay more to graze public lands than private land alternatives. Further, public land grazing permits will have value only if total grazing costs on public lands are less than for private land under the profit maximizing model. Yet, the general observation is that public land grazing permits do have market value (Torell and Doll 1991, Rowan and Workman 1992, Sunderman and Spahr 1994, Spahr and Sunderman 1995, Torell and Kincaid 1996). The GFTG study results imply that these permit values occur without a cost advantage for grazing public lands.[6] From this analysis, the GFTG concluded that private forage comparison methods fail to meet the profit maximizing assumption about competitive markets and the derived demand for forage. The complementary value of public and private resources and the personal utility

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[6] This may have changed over time. The traditional economic model explaining permit value apparently held reasonably well in the 1960s when major grazing fee studies were done to establish the PRIA grazing fee formula. Nielson and Wennergren (1970) found that capitalizing the average difference between total public and private grazing costs from the 1966 Western Livestock Grazing Survey, using a capitalization of about 4%, equaled the average permit value. They concluded that competition and a free market existed for public land grazing permits. Average forage value estimates from their study supported the traditional belief at that time that permit values arise because of a capitalized cost advantage from public land grazing.

from ranching as a way of life are obvious examples of why ranchers pay too much for public forage relative to livestock earning potential (Bartlett et al. 1993).

Permit Value Approach

It is widely believed that the market value of grazing permits arises because grazing fees have been less than the forage value. As noted by Roberts (1963), if forage markets are efficient, competition should equalize production costs by inflating ranchland values by the capitalized value of any resource underpricing.

Past underpricing and the capitalization of permit values has been described as the dilemma we now face in changing grazing fees (Workman 1988, Quigley and Thomas 1989, Torell and Fowler 1992). Past policies have not given all of the benefits of public land grazing to the land agencies. Nearly all ranchers have purchased or inherited the grazing privileges they now hold and higher grazing fees should theoretically cause permit values to fall (Stern 1998).

Underpricing of public land forage, as the reason for why grazing permits have value, is largely justified on theoretical grounds, relating closely to the economic models formulated in Utah (Roberts 1963, Nielsen and Wennergren 1970). Empirical evidence of the correlation between permit value and grazing fees is lacking, however. As noted by USDA/USDI (1992, p. 51), "There is no information on the correlation between the change in permit value and change in grazing fees". This is generally true, but two studies (using the same dataset) have found a correlation between ranchland values and grazing fees. Torell and Doll (1991) used ranch sales data from New Mexico over the 1979-88 period to estimate grazing permit values. A "cost advantage" variable was defined as the difference between the annual private land lease rate (adjusted downward

by 30% to recognize the average value of lessor services) and the public grazing fee. Hedonic ranch price regression models were used to estimate how selected factors affected ranch values, including the apparent cost advantage for grazing on public lands. It was estimated that for every $1/AUM that public forage is priced below its apparent market value, the value of the ranch increased by $29.81/AUM. This implies a 3.35% (1/29.81) capitalization rate.

Xu et al. (1994) demonstrated that dependent variables modeled in empirical economic analysis are often non-negative random variables in nature and used as an example land prices, which cannot theoretically be negative. Thus, distributions for the disturbance term typically used in land value regression models, that allow negative dependent variable values to occur with non-zero probability, are by definition a model misspecification. Using the Torell and Doll (1991) dataset, Xu et al. (1994) demonstrated how to correct this misspecification by truncating allowable dependent variable estimates at zero. With this adjustment, each $1/AUM of cost advantage on public lands was estimated to increase ranch value by $40.45/AUM, implying a 2.47% capitalization rate. In both the Torell and Doll (1991) and Xu et. (1994) studies, the cost advantage variable was statistically significant at the $\alpha = 0.05$ level. Other authors have relied on the 3.35% capitalization rate estimated by Torell and Doll (1991) to estimate forage value (Torell et al. 1993, Sunderman and Spahr 1994, LaFrance and Watts 1995), but the Xu et al. (1994) adjustment to the model suggests a capitalization rate of about 2.5% would be more appropriate. This lower rate of return is similar to the long-term average rate of return western ranchers have made from livestock production (Workman 1986).

The existence of permit value is well documented. Stern (1998) summarized 20 different studies that estimate permit value using various methods. These studies included capitalization of income (see for example Gardner 1962 and Lambert 1987); survey and professional opinion of ranchers, appraisers and ranch brokers (see for example Fowler and Gray 1980 and Torell and Fowler 1985); appraisal of ranch sales that were nearly all federal land or where the permit was valued or sold separately (see for example Gardner 1962, Bartlett et al. 1993, USDA/USDI 1992, Salvo and Kerr 2001); and hedonic regression models (see for example Rowan and Workman 1992, Spahr and Sunderman 1995, Torell and Kincaid 1996, and Xu et al. 1994).

Permit value estimates range from negative amounts to $300/AUM (Stern 1998, USDA/USDI 1992, Sunderman and Spahr 1994). Permit values occur without an apparent grazing cost advantage on public lands (Bartlett et al. 1993), and a major part of this value appears to occur for reasons unrelated to livestock production and profit potential.

Permit value comparison could be used for assigning forage value for a combination of profit from livestock production and utility satisficing behavior. Implying that the value of the permit is solely a capitalized value of excess livestock earning potential, as has traditionally been stated (Martin and Jeffries 1966, Torell and Doll 1991, Bartlett et al. 1993, Sunderman and Spahr 1994), would not be appropriate unless strong empirical evidence can be found that permit values arise only because of under-pricing for livestock production.

Estimating annual forage value from permit value is straightforward after recognizing that both livestock earnings potential and QOL values contribute to the value

of the permit. Grazing permit value is the capitalized value of annual benefits (A) from holding the lease. Thus, the annual value can be estimated as A = i×Permit Value, where i is the discount rate. This annualized value is added to the current grazing fee to estimate the annual value of public land forage (Roberts 1963).

Because grazing permits rarely sell independently, hedonic ranch value regression models have the greatest potential for estimating grazing permit values on a state or regional basis. The level of dependency on public lands varies widely, and federal and state grazing permits are transferable when ranches sell. Thus, an evaluation of ranch sales using hedonic regression models provides a way to estimate permit value from ranch sales data regardless of the level of public land dependency.

Theoretical Concepts of Hedonic Land Value Models

Hedonic pricing models are built on the premise that goods traded in the market place have different bundles of attributes and characteristics. Following the notation of McLeod et al. (1999), these differentiated characteristics can be defined by the vector $\mathbf{Z} = (z_1,\ldots,z_n)$. For ranch values, this vector can further be differentiated into factors that affect production returns and annual earnings, $\mathbf{Z_a} = (z_{a1},\ldots,z_{an})$, and factors that affect amenity or quality-of-life values, $\mathbf{Z_q} = (z_{q1},\ldots,z_{qm})$ (McLeod et al. 1999).

Consider first production value (PV), which includes the potential value of livestock and other agricultural products produced on the ranch, recreation and hunting income, minerals, timber sales, and other business income. Let ANR_t be the expected annual net return to land at time t from these production activities.

Average net returns would be expected to vary from ranch to ranch because of alternative characteristics that influence income-earning potential:

$$ANR_t(\mathbf{Z_a}) = R_t(z_{a1},\ldots,z_{an}). \quad (1)$$

Recognizing the difference in earning potential between ranches, agricultural productive value can be defined in the traditional way by computing the discounted value of expected returns to land (Pope 1985):

$$PV(\mathbf{Z_a}, i) = \sum_{t=1}^{\infty} \frac{R_t(z_{a1},\ldots,z_{an})}{(1+i)^t}, \quad (2)$$

where i is the real discount rate.

If R_t is expected to increase (or decrease) over time at a constant rate g, because of technological change or increasing (decreasing) agricultural prices, equation (2) can be rewritten by expressing PV as a function of current period returns:

$$PV(\mathbf{Z_a}, i, g) = \sum_{t=1}^{\infty} \frac{R_0(z_{a1},\ldots,z_{an})(1+g)^t}{(1+i)^t}. \quad (3)$$

With $i > g$ and for a ranch with characteristics defined by the vector $\mathbf{Z_a}$, equation 3 can be simplified to:

$$PV(\mathbf{Z_a}, i, g) = \frac{R_0(z_{a1},\ldots,z_{an})}{(i-g)}. \quad (4)$$

As noted by Pope (1985), the determinants of the consumptive or quality of life values of rural land ownership are considerably more complex. These amenities may include things like proximity to major population centers, population density of the county, distance to a paved road, distance to and adequacy of schools, aesthetic and recreational appeal, and wealth. The strong economy and wealth made in the stock market were recently identified, for example, as major factors driving the value of U.S. farms and ranches as wealthy investors bought "lifestyle farms" (Henderson 2000). Still other factors like favorable financing arrangements, while not valued for quality of life

appeal, may help the purchaser afford the ranch purchase and thus also influence ranch price (Vanvig and Collins 1986). Observed market value (MV) of rural lands would be estimated as the summation of production and QOL values and a disturbance or error term. Market value would depend on the ranch characteristics that affect production earning potential ($\mathbf{Z_a}$), the characteristics that affect QOL values ($\mathbf{Z_q}$), the real discount rate (i), and the assumed rate of growth of future earnings (g):

$$MV(\mathbf{Z_a},\mathbf{Z_q},i,g) = PV(\mathbf{Z_a},i,g) + QOL(\mathbf{Z_q}) + e. \quad (5)$$

One caution needs to be pointed out here. Equation 5 assumes that market value breaks neatly into production value and QOL. While production value is a relatively known concept, and can be estimated, any misestimate of production value will flow through the model and show up as a misestimate of QOL. There could also be factors affecting QOL that have nothing to do with public land. The point is one needs to be careful in specifying and estimating the model.

If the economic value of public land forage arises only from livestock income earning potential, AUMs of public forage would be an element of $\mathbf{Z_a}$. If the permit has value for QOL reasons, it would be an element of $\mathbf{Z_q}$. It is also possible (and likely) that public land forage is an element of both $\mathbf{Z_a}$ and $\mathbf{Z_q}$. As described in greater detail below, with adequate data, hedonic models could be used to evaluate the way in which public land forage influences land values.

Applications of Hedonic Land Value Models

Econometric models have been used widely to study farmland values and how land prices are affected by annual economic returns. Phipps (1984) estimated that over the 1940-79 period farmland values were unidirectionally caused by farm-based returns.

Other studies also have found that real growth in farm earnings and expected capital gains caused a large part of the rapid increase in farmland values during the 1970s and early 1980s (Melichar 1979, Alston 1986). This same strong relationship between earnings potential and the value of western ranches has not been observed.

Pope (1985) developed a hedonic land value model to evaluate what factors influenced rural land values in Texas. This model followed closely the construct of equations 1 through 5, and Pope's work provided the foundation of the expanded model defined here. Pope did not explicitly estimate the functional relationship between annual returns and land-parcel characteristics (equation 1) but instead used 1981 data from the Texas State Property Tax Board to estimate per acre expected annual returns for each land parcel studied. Other QOL variables considered in the hedonic model included the number of white-tailed deer harvested per square mile, population density, acres devoted to agriculture per square mile, highway mileage to various large Texas cities, and dummy variables defining regions of aesthetic appeal. As indicated by R^2 values, Pope (1985) found only 14.7% of the per acre variation in rural Texas land values was explained by variation in annual returns, but the R^2 value increased to 85.8% when QOL variables were included in the hedonic model.

Hedonic models used to estimate the value of western ranches have varied from very simple specifications to complex equations with numerous variables capturing differences in income earning potential, location, time of sale, and QOL differences. Workman and King (1982) developed a simple regression model where ranch price ($/brood cow unit) was related to ranch size (number of brood cows), distance to markets, time of sale, the value of ranch improvements, and an adjustment for whether the sale

included cattle. At the other extreme, Spahr and Sunderman (1995) and Torell and Bailey (2000) included over 20 variables in their hedonic regression models.

In estimating the value of western ranches, hedonic price models have been applied primarily in two western states, Wyoming and New Mexico. Sunderman and Spahr (1994) and Spahr and Sunderman (1995, 1998) used Wyoming ranch sales data provided by Farm Credit Services (FCS) to estimate the market value of public land grazing permits and to study property tax inequities caused by the large disparity between livestock productive value versus market value of Wyoming ranches. McLeod et al. (1999) used hedonic price models to study the market value of environmental amenities present on Wyoming ranches.

In New Mexico, Torell and various coauthors (Torell and Fowler 1986, Torell and Doll 1991, Xu et al. 1994, Torell and Kincaid 1996, Torell and Bailey 2000) have used hedonic price models to evaluate important determinants of ranch value. Various hedonic ranch value models have been estimated and adapted for use by current ranchers, ranch buyers, sellers, appraisers, brokers and others interested in the New Mexico ranch real estate market. These hedonic models have consistently included percent of grazing capacity coming from public lands, time of sale, ranch size, rangeland productivity, house and building values, and cultivated acreages as explanatory variables.

Using the hedonic models developed for New Mexico, and survey data by Fowler and Gray (1980), Figure 2 plots the estimated average value of BLM, USFS, and New Mexico State Trust Land grazing permits in New Mexico from 1966 to 2000. The average value of deeded land is shown for comparison in those years when estimates were available. Additional detail is provided in Torell et al. (2001) about how historical

New Mexico ranch values were estimated and the assumptions that were made about ranch characteristics.

A more complete description is provided below under the "future research needs" heading about the variables included in the Wyoming and New Mexico hedonic models, and the structure of these models, as we expand the general model defined by equations (1) through (5) to show how regression techniques might be used to evaluate and separate the market influences of income earning potential and QOL factors.

Production Analysis and Linear Programming

Various production analyses and budgeting techniques can be used to estimate the value of public land forage (Bartlett 1983). These procedures are obviously linked to profit maximization, derived demand and the value of forage for livestock production. Early grazing fee recommendations relied exclusively on the commercial livestock production value and productivity of the range (USDI/USDA 1977). Variable fees and the practice of basing fees on the price of beef and lamb were adopted and prevailed in the U.S. Forest Service (USFS) from 1928 until the mid-1960s (USDI/USDA 1977, Backiel and Rogge 1985, Dutton 1953).

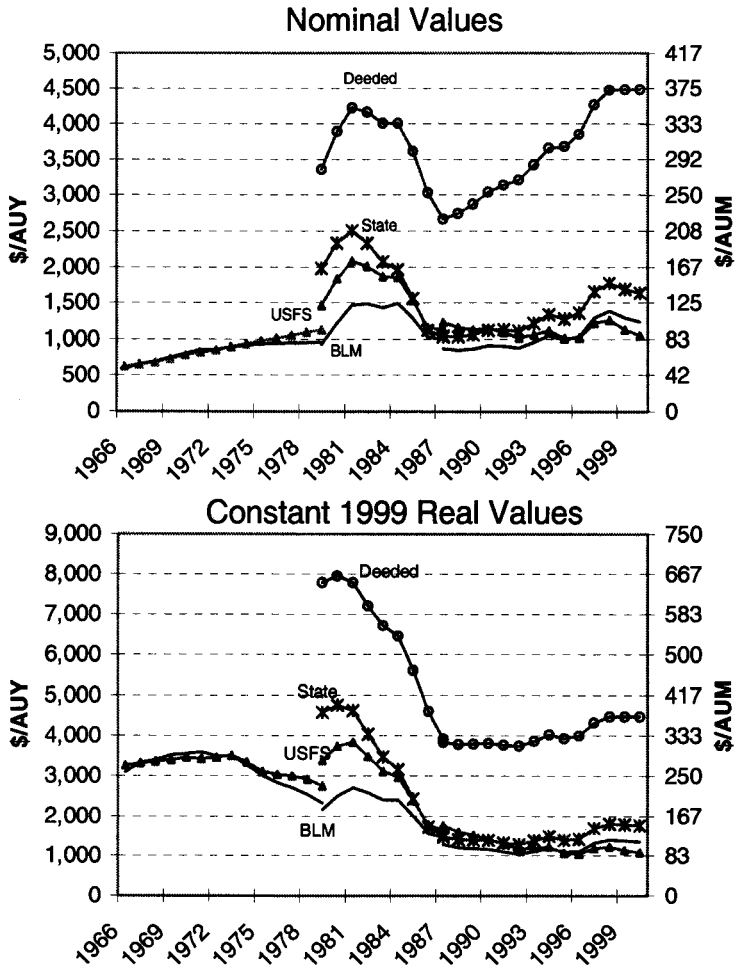
Enterprise budgeting is a production analysis technique that can be used for valuing public land forage. Using this approach, the total gross value of the firm (ranch) output is calculated, and all costs except range forage are deducted. The remaining value is the residual return to the grazing resource. Dividing the residual return by the amount of forage yields the apparent per unit value of the unpriced forage input (Bartlett 1983). The residual return is the economic return to the grazing resource once all other productive inputs have been paid a market rate of return.

Linear programming (LP) has been used to model livestock production and to estimate forage value (Gee 1983, Kehmeier et al. 1987, Hahn et al. 1989). It has been widely used as a way to estimate economic impacts from altered federal land policies (Peryman and Olson 1975, Bartlett et al. 1979, Torell et al. 1981, Gee 1981, Rowe and Bartlett 2001). The dual solution of an LP model provides an estimate of imputed prices for scarce resources, and the "shadow price" can be used as an indication of marginal value for rangeland forage and other scarce resources. As noted by Brokken and McCarl (1987), a resource shadow price is conceptually similar to VMP and factor demand. It is different in a strict theoretical sense because the optimal use of other inputs in the production process may change in the LP analysis but are held constant when constructing VMP curves. The value of the dual variable is affected by product prices, marginal productivity of the inputs, and the prices of all inputs.

As an application to forage valuation, Gee (1981) and Hahn et al. (1989) used LP and resource shadow prices to estimate forage value on USFS and BLM lands. Profit-maximizing LP models were developed from ERS budgets. Shadow price estimates of forage value in 1981 were estimated to be $10.86/AUM for BLM and $11.58/AUM for USFS (Gee 1981). Hahn et al. (1989) updated Gee's work and reported shadow prices for each of nine USFS regions and a national average. Values ranged from $9.22/AUM in Region 3 (New Mexico and Arizona) to $15.11/AUM in Region 5 (California). The national average was $12.97/AUM.

Problems have been noted in using shadow prices for resource valuation. Most notably, different shadow prices can be obtained by writing equivalent but different

Figure 2. Average nominal and real grazing permit values, and deeded land ranch values in New Mexico, 1966 - 1999.



USFS, BLM, and State permit value estimates are not continuous because estimates were from different studies (Fowler and Gray 1980, Torell and Kincaid 1996, and Torell and Bailey 2000).

formulations of the constraint set, and it matters what and where costs are included in the objective function of the LP model. The shadow price estimates of value reported by Gee (1981) measured the return above cash costs per AUM. When depreciation costs and the value of family labor were considered, shadow price estimates of value decreased to $6.61/AUM and $7.05/AUM for BLM and USFS, respectively. Hahn et al. (1989) performed additional analyses in which fixed costs and opportunity costs were subtracted from the objective function to estimate long-run shadow prices. These shadow price estimates averaged $0.49/AUM when family labor, interest on investment and capital replacement were included as cost items in the LP model.

The difference in short-run versus long-run shadow prices reported by Hahn et al. (1989) is an example of the differences in shadow prices that can be obtained when different costs are included in the objective function, or when costs are included in different places in the objective function. As noted by Godfrey and Nielsen (1994), it conceptually does not matter whether non-fee grazing costs are included in the LP model as a cost to raise a cow or added to the cost of grazing a particular forage resource. Each cow raised will require forage, and non-fee costs can be considered under the "Cow-raising" activity or added as a non-fee expense to the "forage harvesting" activity. The only conceptual problem is to assure that non-fee forage harvesting costs are not double counted. Godfrey and Nielsen (1994) demonstrate, however, that generated shadow prices for forage depend on the allocation of non-fee costs between the forage harvesting and livestock raising activities.

Production analysis and linear programming require subjective judgment in defining typical production costs, production rates, and ranch investments. A wide range of forage values can be justified depending on the parameter definitions of the production models. Further, given the wide differences in production strategies, resources, and the economic position of western ranches (Gentner 1999), it is likely that numerous models and scenarios would be required to determine satisfactory forage values from production analysis. Production analysis and linear programming use profit maximization and livestock returns to value forage. QOL reasons for ranch ownership and resource use are ignored.

Competitive Bidding

Establishing a market for public land forage through a competitive bid system has strong theoretical appeal because forage value would be defined by the forces of supply and demand. It has been proposed and studied numerous times in the past (Gardner, 1962, 1963, Nielsen 1972, Martin and Jeffries 1966, USDI/USDA 1977, USDA/USDI 1992). However, the option of moving to a competitive bid system has been repeatedly rejected by the federal land agencies. They believe it would be disruptive to the stability of permittees and rural communities dependent upon public land forage, and would not be manageable given the isolated and scattered nature of many public land grazing permits, especially with current permit structure, regulation, and staffing (USDI/USDA 1977, USDA/USDI 1992, USDI/USDA 1993).

Competitive bidding for public land forage is done on a very limited basis. For example, forage is leased on the McGregor Bombing Range in southern New Mexico and at Fort Meade in South Dakota (USDA/USDI 1992). With limited bids offered, Fowler

et al. (1994) found for the McGregor Bombing Range that annual bid rates varied greatly depending on rangeland conditions in west Texas and eastern New Mexico. When forage was depleted on area ranches, bidding and bid amounts increased, and the bombing range became a viable substitute forage source.

If forage is demanded for a combination of profit potential and utility-satisfying behavior, a competitive bid process could be used to determine the market value of public land forage, regardless of the specific motives of the lease participants. Because of the increased non-fee grazing costs on public lands, added regulations and management oversight by the federal land agencies and the general public, average bids received would be expected to be less than those on comparable private lands. Bids also would be expected to exceed the derived value of the forage in producing livestock, given the multiple reasons for why ranchers buy ranches and lease forage.

Contingent Valuation

The contingent valuation method (CVM) has received considerable attention in the resource economics literature and has been used to value many different goods, most commonly aesthetic and environmental improvements and recreational activities (Carson, et al. 1996, Van Kooten and Bulte 2000). Contingent valuation (CV) uses surveys to elicit information about the maximum amount an individual would be willing to pay (WTP) for an amenity, or the minimum amount an individual would be willing to accept (WTA) to forgo consumption of an amenity. Theoretically, CV analysis examines this tradeoff in light of an individual's underlying utility function (u). Following An (2000), a person's WTP for an amenity, offered at a fixed level, is defined as the dollar amount Y that equalizes two indirect utilities such that

$V_1(I\text{-}Y \mid Z, \varepsilon) = V_0(I \mid Z, \varepsilon)$

where, V_1 and V_0, respectively, are the individual's indirect utility with, and without, the amenity, I is the individual's disposable income, Z is a vector of observed social demographic characteristics, and ε is a scalar variable representing unobserved personal characteristics. Given the assumption that V_1 is monotonically increasing in u for any fixed (Z, ε), an inverse utility function exists such that $U(V_1(u \mid Z, \varepsilon); Z, \varepsilon) = u$ for all $u \geq 0$. WTP can then be expressed as

$Y = I - U(V_0(I \mid Z, \varepsilon); Z, \varepsilon) \equiv \phi^*(X(I,Z),\varepsilon)$.

Using CV methodology, Y, Z, and I can be elicited from members of a selected population and their WTP assessed by econometric techniques.

While the majority of contingent valuation studies have attempted to value non-market goods, contingent valuation has also been used to value goods traded in markets (Harrison 1989; Kahneman and Knetsch 1992) or quasi-markets (Hof et al. 1989, Carson et al. 1996). Although contingent valuation was originally designed to elicit estimates of use value, more recently the emphasis has been on eliciting nonuse values (Jakobsson and Dragun 1996).

Contingent valuation is not without its weaknesses in being able to elicit a person's true WTP or WTA. The methodology suffers from the same potential biases that are prevalent to survey research in general, such as interviewer bias and nonresponse bias, but the two major concerns with CVM are hypothetical bias and strategic bias.

Some researchers contend that a fundamental difference exists between the way an individual makes a hypothetical decision relative to an actual decision (Neill et al. 1994). Hypothetical bias results from the inability of a respondent "to accurately predict

how they would behave if a market were created" (Bishop and Heberlein 1990, p.92). The respondent's understanding of the circumstance or amenity they are asked to value may be limited or imprecise. An individual also may find it difficult to express their value for, or feelings about, an amenity in monetary terms. If the respondent relies on the starting bid price presented in the CV instrument as an indication of what the value of the amenity should be, starting-point bias can result (Bishop and Heberlein 1990).

The desire to intentionally mislead the researcher in order to influence policy has been termed strategic bias (Jakobsson and Dragun 1996). Individuals may express an unrealistically high WTP if they believe they will not actually have to make the payment, yet believe they can influence the desirable supply of the amenity in question by giving a high value. Conversely, they may understate their true value if they feel it will decrease the amount they will actually have to pay (Bishop and Heberlein 1990).

Several researchers have found that WTP estimates derived from CVM surveys exceed those revealed in experimental or real life markets (Cummings et al. 1995, Loomis et al. 1996, Champ et al. 1997, Seip and Strand 1992). One behavior thought to explain this abnormality is the tendency of some respondents to agree with questions regardless of content, i.e., to say "yes" to a high dollar amount when they would not actually pay that amount. This condition also is known as yea-saying or nay-saying. Blamey et al. (1999) define yea-saying as "the tendency to subordinate outcome-based or "true" economic preferences in favor of expressive motivations when responding to CVM questions." Yea-saying can be motivated by social pressures or a desire to express their attitudes or values (Blamey et al. 1999). Basically the respondent expresses agreement (or disagreement) with the larger concept of amenity value or desirability of a

positive (or negative) policy action contained in a CV scenario rather than to the specific pairing of price and characteristics of the good presented. A person may say "yes" to a price of $1000 to acquire a particular amenity, when in actuality what they are really expressing is agreement that the amenity is something they value more generally.

Results of experiments by Cummings and Taylor (1998) show that the questions asked in a CV survey cannot be frivolous and that the exercise must be viewed as "real" to avoid some of the biases associated with CV analysis. The respondents must feel that their responses will have a substantive purpose, such as influencing public policy decisions. This can be portrayed by something as simple as stating that the results will be made available, or presented, to policy makers (Rowe et al. 1991, Cummings and Taylor 1998).

In their review of grazing fees and public land management, Rostvold and Dudley (1992) suggested that the CV method be used to impute the economic value derived from public lands. To date, Hof et al. (1989) has been the only CV study attempting to elicit WTP for grazing on federal lands. They applied CV in four different formats to value public land forage. Two formats elicited ranchers' willingness to pay, and two examined their willingness to sell. All questions were open-ended[7] to eliminate starting point bias. An open-ended format does not offer the respondent information regarding the potential value of the amenity, but allows them to devise their own maximum willingness to pay or minimum willingness to sell (Bishop and Heberlein 1990).

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[7] In open-ended CV, respondents are asked to fill in a dollar amount representing their maximum willingness to pay or minimum willingness to accept compensation, depending on the question, as opposed to a closed-ended format in which they are asked to respond yes or no to a specified dollar amount.

The price-response formats of the Hof et al. (1989) survey tended to result in either the current federal grazing fee or the private lease rate. This would appear to indicate that respondents were very familiar with the grazing fee issue and might have biased their response on expected outcomes. Quantity response formats in which respondents were asked to respond to changes in grazing fees in terms of the number of cattle they would graze, resulted in all or nothing bids, i.e., they responded with either the number of cattle they currently grazed or they said they would graze no cattle.

Using CV to value goods, such as public land grazing, may result in biased responses by users who are dependent on the good for their livelihood and have a direct economic interest in the answers given. Because of this apparent response bias, Hof et al. (1989) concluded that CV would be an inappropriate way to value public land forage and that other applications of CV where markets exist may also be affected by the current fee structure and institutions allocating use.

National and Regional Forage Values

Public land forage values and grazing fees have been controversial since the inception of the Forest Service in 1906. One element of the controversy is the idea held by many that forage values should be different throughout the West because of forage type, location, level of range improvement and a number of other factors. They believe that, rather than one forage value for all public land grazing, there should be multiple values determined by site-specific factors that impact the value of forage (Robertson 1978, LaFrance and Watts 1995).

For many years, Forest Service grazing fees were based upon two separate surveys of comparable private rangeland that were used to derive forage values on Forest Service rangeland. These values varied by state, national forest and in some cases, ranger districts within a forest (Rachford 1924). After 1931, these values were updated by relative changes in livestock markets from base periods of 1921-30 (for cattle) and 1920-32 (for sheep) (Dutton 1953). Prior to 1968, the USFS had 19 different base grazing fee rates for cattle and 17 for sheep on the western national forests (Nielsen 1972).

In 1969, the USFS and BLM established a nationally uniform grazing fee that was to be implemented over a ten-year period. Prior to completion of the ten-year period, the Public Rangeland Improvement Act (PRIA) was passed by Congress, and a new fee schedule established for 1979. The uniform fee policy was based upon recommendations from a Western Livestock Grazing Survey (Little 1967, 1968; Houseman 1968), which found that total grazing cost (fee and non-fee) differences between ranching areas were not large in relation to differences within ranching areas. The authors concluded that given the large variability in grazing costs and forage values, one national value for public land forage was justified.

This conclusion was in contrast to Robertson (1978) and others who believed forage values had to be different in different areas of the West and argued for variable fees based on range quality differences. But as noted by Nielsen (1972, p.5), "Many people believe that forage quality should play a vital role in determining grazing fee levels, i.e., the higher the quality and quantity of forage per acre, the higher the fee per AUM. The data available (grazing cost survey data) do not support this notion."

Calculating lease rates on a forage quantity basis ($ per AUM) eliminated differences observed on a quantity per acre basis.

Other researchers have also failed to find significant differences between regions based on cost of production studies, largely because of extreme variation in observed grazing costs both within and between regions. Bartlett et al. (1993) and Van Tassell et al. (1997) reported on a comprehensive assessment of grazing costs and forage values estimated across broad ecological regions (Great Plains, Northern Rocky Mountains, Intermountain/Columbia Plateau) in Idaho, New Mexico and Wyoming. They found as much variation in grazing costs and forage values within the twelve ecological regions included in the three states as between them. Similar variation was found in relation to total grazing cost when considered on a state basis, with only New Mexico public land cattle and Idaho public land sheep operations being statistically different from the grazing cost estimates for the other states. In terms of the forage value implied from the total cost approach, most values were similar across states, with only New Mexico sheep operations having significantly higher forage values (Bartlett et al. 1993). These authors concluded that one national value was justified because statistically defensible regions could not be defined.

Several researchers have justified variable grazing fees based upon stratification of ranch sales and/or private lease rates. As noted above, Spahr and Sunderman (1995) examined Wyoming ranch sales and found that in the Wyoming ranch real estate market, grazing permits were valued differently between ecological regions and by type of lease. Similarly, permit values have generally been found to be lower in the seasonal grazing northern states, as compared to Arizona and New Mexico where yearlong grazing is

common (Bartlett et al. 1993). The permit valuation method suggests that annual forage values are lower in the northern states.

LaFrance and Watts (1995) found private lease rate differences between states. They argued that because of these differences, forage values and grazing fees on public lands should also differ by state. These authors suggested separating the western region into three areas for the purposes of calculating forage values on public lands: 1) Arizona, California and New Mexico; 2) Colorado, Montana and Wyoming; and 3) Idaho, Nevada, Oregon, Utah and Washington. Similarly, Tittman and Brownell (1984) used appraisal techniques to delineate six separate pricing areas in the western U.S., based on observed differences in grazing lease rates and other lease provisions. Fowler et al. (1986) used this same data set for New Mexico and indicated that lease prices were not homogeneous and suggested three separate pricing regions for New Mexico.

Van Tassell and McNeley (1997) also found evidence that private lease rates were statistically different between states in the western region. They used regression techniques to estimate the major factors influencing private lease rates and found these to be lagged yearling prices, current year hay prices, lagged lease rates, and current input costs. Regional differences were also noted. Areas suggested by their analysis included: 1) Washington, Oregon, Idaho and Utah; 2) Montana, Wyoming, Colorado, Nevada and California; and 3) Arizona and New Mexico.

Applying the total cost approach to private grazing leases yielded similar variable results. Rimbey et al. (1994) summarized the non-fee costs of grazing (all operating costs excluding the lease rate) on 134 private leases in Idaho, New Mexico and Wyoming. This study found that New Mexico private grazing costs were statistically greater than

those in Idaho and Wyoming. Yet, as part of the larger Incentive Based Grazing Fee Study, the main conclusion remained that the total cost approach yielded inconsistent results, with public land ranchers willing to pay more in total than the apparent value of the forage for livestock production (Bartlett et al. 1993).

As shown by this past research, there appears to be conflicting evidence about the need for regional forage values and how these regions might be defined. As noted by Houseman (1968) and Bartlett et al. (1993), total grazing costs for public and private land ranchers exhibit a great deal of variability, and in fact total grazing costs (fee and non-fee costs) are as variable within ranching areas as they are between ranching areas. No statistically defensible regions of value can be defined based on total grazing cost differences. Yet, as shown by LaFrance and Watts (1995), Van Tassell and McNeley (1997), and Tittman and Brownell (1984), average lease rates are statistically different in different states and areas of the West. Grazing permit values are also different for different states (USDA/USDI 1992). But, average lease rate differences and average permit value differences are in contrast to each other. Lease rates are higher in the northern states where seasonal grazing is common, whereas permit values are higher in the southwest states of Arizona and New Mexico where yearlong grazing is common. Consequently, forage values derived through lease rate comparison and permit valuation suggest conflicting regional values.

Perhaps the main conclusion that can be drawn about regional forage values is that these values are extremely variable, both within and between states and regions. Houseman (1968) emphasized that the cost differences found between allotments should be interpreted as the actual situation and not as an indication of inaccurate data. There is

an extreme amount of variation in what people pay to lease forage, and as we emphasized above, much of this difference has nothing to do with the value of the forage for livestock production. Only those valuation procedures that can capture both livestock production value and QOL values can potentially estimate regional differences in the willingness to pay for forage. It is likely these regional values will have more to do with differences in the scenic view and hunting opportunities than it will with differences in livestock rates of gain and pounds of beef produced.

Updating Forage Values Through Time

A factor critical to determining public land forage values is the development of a process for updating these values as markets and grazing conditions change through time. Over the history of administered grazing on public lands, updates have varied from periodic appraisals of public land forage values based upon comparable private lands (Rachford 1924; Tittman and Brownell 1984) to indexing values based on private lease rates, livestock prices and prices paid on a national basis (Dutton 1953; Brokken and McCarl 1987). Appropriate methods for updating forage values will obviously depend on the process used to initially determine forage values.

Market Price Comparison

Public land forage values implied from comparisons with private grazing markets can be estimated annually. Various lease rate comparison studies described above, including those of Fowler et al. (1985), Torell et al. (1988), Torell and Bledsoe (1990), Torell and Fowler (1992), Rimbey et al. (1992), Rimbey et al. (1994) and LaFrance and

Watts (1995) support adjusting downward the published NASS private lease rates in each state by a factor of about 0.70 to arrive at forage value. This downward adjustment is necessary to account for services provided to lessors of private forage that are not provided on public lands. Because lease rates are published annually, no updating mechanism would be necessary. However, efforts should be made to revise the NASS survey instrument so that actual market transactions involving private grazing leases are captured, rather than opinions about the "going private grazing lease rate in your area". Sample size of the NASS survey should also be expanded to insure that state-level values are statistically valid.

Total Cost Approach

The total cost approach has yielded inconsistent valuation results through time. Repeating these intensive survey studies to provide updates is expensive, and any additional cost studies could be expected to reach inconclusive results. Updating forage values with an index similar to the Forage Value Index provides a means of update, but this process does not address the inconsistencies found with the valuation procedure.

Permit Value Approach

Generally, only periodic estimates of permit value are available or can be expected. Long-term estimates of permit value have been available in New Mexico (Figure 2), but these estimates are generally not current with a lag existing between when ranches sell, ranch sales data are recorded and hedonic ranch value models developed. Past estimates of permit value obtained by surveying knowledgeable professionals

(Fowler and Gray 1980, Torell and Fowler 1985) have been consistent with estimates generated from hedonic price models (Torell and Doll 1991, Torell and Kincaid 1996).

Hedonic land value models for estimating permit values appear to work well in the southwest where yearlong grazing is practiced. Similar research has been undertaken on seasonal range situations in Wyoming (Sunderman and Spahr 1994, Spahr and Sunderman 1995, 1998), but as discussed below, permit value estimates provided by these research efforts has been inconsistent and with greatly different permit value estimates over time and between studies. Other hedonic ranch value models (Rowan and Workman 1992 in Utah and Iqbal 1993 in Oregon) estimated permit values to be similar to appraised estimates (USDA/USDI 1992, Bartlett et al. 1993). But, northern ranch value models do not seem to statistically fit the data as well as the yearlong grazing models appropriate for the Southwest. Perhaps QOL values are a more important component of ranch value in these northern states. If so, additional detail about the scenic and recreational potential of each ranch studied, similar to the efforts of McLeod et al. (1999), will be needed to adequately explain the wide variation observed in ranch and permit values with seasonal grazing ranches of northern states.

None of the latter hedonic models and research efforts has yielded the long-term permit value and forage value estimates that the New Mexico work has. If a system is devised to use periodic permit value estimates to imply forage value across broadly defined areas (similar to that used by Bartlett et al. 1993), indexing can be used to provide annual updates until additional studies evaluate changes in permit value. Instead of the FVI (an index of private grazing lease rates), an index that tracks changes in asset values (e.g., land and buildings) over time could be developed or used to provide the

annual updates. Additional research would be needed to identify a preferred index and the components and weighting of the index. As demonstrated by the different trends in permit and deeded land values shown in Figure 2, an index of private agricultural land values may not be adequate, because public land policy and uncertainty about the future of grazing on public lands are additional factors affecting the value of public land grazing permits. There is no reason to believe the value of grazing permits will necessarily follow the trend of deeded land values.

Production Analysis and Linear Programming

Estimating forage values based on production analysis and ranch-level linear programming models suggest forage value arises only because of livestock production potential. QOL values are ignored and the true value of the forage will be underestimated. In addition, the expense of building production economic models (generally based upon primary data collection), specification of the model and breadth of coverage (state, regional, etc.) limit their applicability in defining public land forage values. Only if the policy or research objective was to determine the value of forage for livestock production would this approach be appropriate.

Competitive Bid System

Under a competitive bid system, a process would be developed to solicit open, competitive bids for grazing rights on an annual or multi-year basis. If this approach were used, there would be no need to develop a method to update forage values as a market for public land forage would be created and market-clearing prices would be determined. If not all public lands could be competitively leased because of the small or

scattered nature of some permits, an indexing or average valuation of those that did lease could be used to value those that were not competitively leased or priced.

Contingent Valuation

This method is again dependent upon primary data gathered through phone or mail surveys and the expense is high. Given the expense of generating these surveys, indexing forage values determined at a point in time appears to be the only possible method of updating values through time.

Future Research Needs

Any forage valuation method that is aimed at determining the total value of public land grazing should be able to incorporate both livestock production and QOL market influences because both of these factors influence the willingness of users to pay for forage. This eliminates the use of production analysis, total cost analysis and market price comparison methods. Competitive bidding has been proposed as a method to capture the full value of public land grazing (Gardner 1962), but because this method is limited by practical and political concerns, a competitive bid system may not be possible.

Permit value has the potential of providing a direct and site-specific estimate of forage value that accounts for production as well as quality of life values. CV also has been shown to capture the WTP for goods and services that are not exchanged in a market. CV may have the potential to assess the total value or willingness to pay for public land grazing as long as respondents do not associate the valuation with the grazing fee issue.

We propose that the further study of permit values and CVM be further explored as potential techniques for valuing public land forage. These two methods offer the greatest opportunity to capture both production and QOL values. In this section, we outline approaches for using these techniques to value grazing on USFS lands. We first examine using hedonic ranch value models to estimate permit value by utilizing ranch sales data where the value of public and state land grazing permits has been capitalized (or potentially capitalized) into the market value of the ranch. This discussion presents a procedure that could be used to separate livestock production value and QOL value components using econometric methods and ranch return data. We next investigate the use of CV for valuing public land forage. We consider some issues that are germane to designing and implementing a survey that will elicit the true value of public forage, and detail a CVM approach we suggest be investigated further. We conclude by presenting suggestions for updating USFS forage values on an annual basis.

Comment: Page: 49
I don't see anything on annual updating in LVT's latest draft.

Hedonic Models and the Permit Value Approach

None of the hedonic ranch value models in the literature have attempted to separate the market influences of production earning potential from the ranch (Z_a) and QOL market factors (Z_q). Various explanatory variables have been considered, but the reason why a particular factor influenced ranch value is not clear given past model definitions. We next review several issues that are important in defining hedonic land-value models and further review how these models have been defined in past studies. We then propose a two-step procedure that might be used to refine permit value estimates and further define why grazing permits have market value.

Defining the Dependent Variable

As detailed above, Pope (1985) provided a framework for assessing the relative importance of annual livestock earnings potential and QOL influences to rural agricultural properties in Texas using a hedonic regression model. He estimated how per acre market values changed with changes in income earning potential and desirable QOL characteristics. Defining the dependent variable on a $/acre basis was adequate, if not preferred, for Pope's work in Texas, and other areas with primarily deeded lands. However, defining the dependent variable in land value models is a problem for other western states because leased public and state lands are attached to the base ranch property. This follows because the ranch purchaser buys the privilege to graze public lands but does not acquire title to these lands. For public land-dependent ranches, it is not possible to compute a valid per acre price, which is the standard dependent variable used for farm and ranch value analysis. A price per deeded acre can be computed, but this is misleading. Small deeded acreages with large public land permits will have a very high price per deeded acre because the value comes largely from acreages (grazing permits) not counted in the denominator.

As a solution, total ranch value has been used as the dependent variable in some hedonic land value models (Torell and Fowler 1986, Rowan and Workman 1992, Spahr and Sunderman 1995, McLeod et al. 1999). This creates problems because regression coefficients measure average adjustments across all ranch sizes, and these adjustments will be too large for small ranches and too small for large ranches. Further, while high R^2 values for the model would be expected when total ranch value is the dependent variable (larger ranches obviously sell for more), heteroscedasticity will likely be a problem as

larger ranches have larger variance in total selling price. A major advantage of specifying the dependent variable as the total sale price is that a direct value estimate for both public and private forage value is obtained (see for example Rowan and Workman 1992).

Other hedonic models have defined the dependent variable to be $/brood cow, $/AUM and $/AUY (animal unit yearlong) selling price (Martin and Jeffries 1966, Workman and King 1982, Torell and Doll 1991, Torell and Kincaid 1996). With QOL factors influencing ranch prices, these definitions have problems as well. Dividing ranch selling price by the number of cows, AUMs, or AUYs to estimate ranch value on a $/livestock-unit basis tacitly assumes that the ranch value arises only from livestock production. It does, however, provide standardization to a per-unit value that potentially eliminates some of the statistical problems encountered when total ranch value is used as the dependent variable.

An additional complication where seasonal grazing of rangelands is common is the seasonal interdependence of forage from alternative sources. Livestock do not generally graze public lands or rangeland yearlong in northern states. A ranch may have ample spring and summer forage from public and deeded lands, but have limited hayland for winter-feed production. The opposite situation may also be true. Thus, for seasonal-grazing areas, the most common measure of ranch value is $/AUM or $/AUY. With seasonal grazing, the influence of seasonal forage balance (or lack thereof) on ranch price and the enhanced QOL values from high mountain scenery and recreational opportunities have resulted in relatively poor statistical results for hedonic ranch price models. Added detail is needed to consider seasonal forage supply and demand.

Estimating Annual Return Influences

Two studies have attempted to estimate how ranch values vary as income earning potential varies. First, as noted above, Pope (1985) used 1981 data from the Texas State Property Tax Board to estimate per acre expected annual returns from each rural Texas land parcel considered. Annual returns included agricultural income, government payments, and hunting leases. Annual income explained about 22% of the average market value of Texas rural properties. Similarly, Torell and Bailey (2000) included an estimate of annual livestock returns[8] as an explanatory variable. They could find no statistical relationship between variation in current and lagged livestock returns and New Mexico ranch values, and concluded that New Mexico ranch values appear to be impervious to market forces based on the price and value of beef production. Wildlife, hunting income and oil and gas revenues were not included in the annual returns assessment and only broad regional estimates of livestock returns were available. It is possible that annual ranch return estimates were not specific enough to measure market differences.

At least four potential sources of data are available for defining an explanatory variable that would give expected annual earnings from a particular ranch. First, the tax commission collects detailed land-parcel income information in some states, similar to the data used by Pope (1985). Second, various western universities prepare livestock cost and return estimates for their states. Third, in-depth ranch analysis is performed for specific ranches in some states and areas using standardized budget programs such as FINPACK (Center for Farm Financial Management 2000) or SPA (McGrann 2000).

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[8]Return estimates were broadly defined from the livestock cost and return series published annually by NMSU for various areas in New Mexico and measured for different years (see for example Torell et al. 2000).

Fourth, Farm Credit Services (FCS) appraisers in selected states perform an income appraisal of individual ranch sales and compare this value to market sale price. In New Mexico, for example, FCS appraisers use information about the number of AUMs from alternative sources to compute the net annual expected lease value of the forage available on the ranch and add to this the potential mineral and wildlife income. An income appraisal is conducted for each ranch sale.

Estimating QOL Influences

Ranch characteristics that affect amenity or QOL values (Z_q) have been defined in various ways. McLeod et al. (1999) used geographic information systems (GIS) data to quantify amenity resources on Wyoming ranches. GIS data was used to visualize the scenic view a ranch purchaser would see at the centroid of a parcel of land. GIS data were also used to quantify the abundance and quality of wildlife and fish habitat, as well as accessibility. The GIS data were expensive, costing the researchers nearly $400/observation (personal communication with Chris Bastian, extension economist, University of Wyoming, September 1999). Spahr and Sunderman (1995, 1998), Sunderman and Spahr (1994), and Rowan and Workman (1992) used a subjective assessment of scenic and recreation potential for each ranch and included this assessment as a dummy variable. Other QOL variables have included distance to town (Pope 1985, Torell and Bailey 2000, Rowan and Workman 1992) and population density of the county (Pope 1985, Torell and Bailey 2000).

Similar to the procedure used by Pope (1985), Torell and Bailey (2000) assessed aesthetic values by using dummy variables to define regions of aesthetic appeal. These dummy variables defined ranching areas where aesthetic values were expected to be

higher because of mountainous terrain and desirable aesthetic characteristics. Spahr and Sunderman (1995) also considered regional differences using dummy variables. Similar dummy variable procedures have also been used to value the aesthetic and recreational value of water based on the location and view differences of shoreline and near-the-lake homes (Lansford and Jones 1995).

Ranch Size and Productivity

Ranch size would be expected to be a factor determining total livestock carrying capacity and annual earning potential, and as such ranch size would be expected to be an element of $\mathbf{Z_a}$. Further, people feel good about owning land (Henderson 2000), and ranch size is also likely an element of $\mathbf{Z_q}$.

Ranch size has been included in hedonic models in various ways. When the dependent variable of the model is expressed as total value, ranch size has been considered by including variables that measure the number of AUMs or AUY of grazing capacity included from deeded, public land and state trust land sources (Torell and Fowler 1986, Rowan and Workman 1992, Sunderman and Spahr 1994). When the dependent variable is expressed on a $/cow, $/AUY, or $/AUM basis, measures of ranch size have been expressed as acres or sections of total ranch size (Torell and Doll 1991, Torell and Bailey 2000).

Rangeland productivity has also been shown to influence ranch values. This would theoretically occur because of the income earning potential from the added carrying capacity of the ranch. As noted by Torell and Kincaid (1996), more productive ranches and larger ranches have been shown to sell for less on a $/AUY basis. While the

total value of the ranch will increase as more AUYs are added, the value of each AUY will decrease at a decreasing marginal rate.

As shown by Torell and Doll (1991), when total ranch value is related to the animal units of grazing capacity coming from deeded and public land sources, the implied model on a $/AUY basis is related to the percentage of carrying capacity obtained from deeded and public land sources. With this specification, the regression coefficients for a level of public land dependency give the price adjustment if some of the AUYs on the ranch are from public land instead of deeded land (Torell and Kincaid 1996). These adjustments have been shown to change over time as public land policies change and attitudes about the agencies change (Torell and Kincaid 1996, Torell and Bailey 2000). Further, as shown by Torell and Doll (1991), marginal grazing permit values are a function of the numerous explanatory variables included in the regression model, including ranch size, productivity, and time of sale.

Some hedonic land value models have included various adjustments to evaluate how grazing capacity coming from alternative sources and areas affect ranch market value. Spahr and Sunderman (1995) considered, for example, the difference in permit value for BLM (Section 3 and 15 lands from the Taylor Grazing Act), Forest Service and state trust lands. These values were further differentiated by area of the state. Permit values were found to be different by region for Section 3 and Section 15 BLM lands, with permit values ranging from approximately $59/AUM to $220/AUM. Forest Service leases added significantly more to ranch value with estimates ranging from $142/AUM to $275/AUM. Wyoming state trust permits were found to be statistically insignificant, and for other models statistically significant but of negative sign. Consistency of these

estimates over time, though, has been lacking as they were significantly different from those they estimated in an earlier report (Sunderman and Spahr 1994) and in a subsequent study (Spahr and Sunderman 1998).

As a comparison to these Wyoming permit value estimates, Torell et al. (1993) reported the average allocation of permit value assigned by Farm Credit Services appraisers for 359 BLM and 43 USFS permit sales in Wyoming, negotiated over the 1985-92 period. Average appraised values for Wyoming permits were estimated to be $36/AUM for BLM and $47/AUM for USFS. These values were also similar to permit value estimates provided for Idaho.

Time of Sale

At the state level there may not be enough ranch sales in a particular year to adequately estimate hedonic regression models. Two procedures could be used to overcome this limitation. First, ranch sales negotiated over a relatively narrow time span (several years) can be used to estimate regression parameters over the extended data period. Regression parameters would provide average values across all years studied. The second procedure, which has been widely used, includes time of sale as a trend variable in the hedonic regression model (Torell and Kincaid 1996, Rowan and Workman 1992). An alternative, and perhaps preferred procedure, has used time-of-sale dummy variables (Spahr and Sunderman 1995, Torell and Bailey 2000). By this procedure, a date of sale dummy variable is defined to be a linear combination of the start and end points for the year in which the sale occurred. For example, if the ranch sale occurred at the end point (Dec. 31), the dummy variable for that year is assigned the value zero (0), but at sale

dates earlier in the year the dummy variable defines the proportion of the year that still remains.

Separating Livestock Production Value and QOL Value Components

Pope (1985) demonstrated that with estimates of ranch-specific earning potential, hedonic models can be used to estimate the relative importance of annual income earnings in determining rural agricultural land values. However, his data and procedure did not allow direct estimation of the avenue by which specific ranch characteristics influence market value. He did not estimate annual ranch earning as a function of ranch characteristics as suggested by equation 1 above.

Separation of ranch value into livestock production value and QOL value would be important if a policy prescription required a fee or charge based only on use-value or earning potential of the ranch. For example, agricultural lands in most western states are taxed on the basis of productivity for crop and livestock production and not on market value (Spahr and Sunderman 1998). Similarly, as discussed above, the current grazing fee is based on grazing cost differentials between private and public lands, and profit potential from livestock production is the traditional reason ranchers were thought to demand forage. An estimate of grazing permit value can be used to derive forage value, but this value apparently includes both livestock production and QOL values. If it were desired to continue basing grazing fees only on livestock production value, this would require identification of the avenues by which grazing permits have value. We next propose a hedonic regression model that could be used for this value separation if adequate data were available. Equations (1) and (5), defined above (p. 25), suggest a

simultaneous equation regression model using two-stage least squares would be necessary to estimate ranch values in this case.

Estimating the Site-Specific Ranch Returns Function

Cross-section and time series data could be used to estimate equation 1, the ranch returns function. This would require paired data defining ranch-specific estimates of expected net annual returns as they relate to ranch characteristics and conditions. Ranch characteristics affecting annual returns ($\mathbf{Z_a}$) might include rainfall, rangeland productivity rating, ranch size, topography, level of range improvement, accessibility, distance to town, wildlife numbers, wildlife habitat, miles of fishing stream, and timber volume, among others. Because expected ranch earning potential are capitalized into land values, a long-term estimate of annual earnings would be most appropriate.

Proxy variables might be used to measure selected ranch characteristics. For example, because public lands are thought to be of rougher topography and lower quality then deeded lands, and to be more expensive to graze (Bartlett et al. 1993), the number of AUMs of grazing coming from different land types could potentially be used as proxy variables defining differences in topography, distance from the ranch headquarters, and forage quality. Another proxy variable might be ranch location that gives a regional definition separating ranches by similar geographic features. The amount and type of hay land, hay production on the ranch, or winter feeding cost for the ranch would be an expected explanatory variable because winter feeding is a major part of the annual ranch expense. Using the variable definitions in Table 2, current period expected annual ranch returns might be estimated as:

$$ANR_0(\mathbf{Z_a}) = R_0(DEEDAUY,BLMAUY,USFSAUY,STATEAUY,HAY,$$
$$SIZE,PROD,LOCATION_i,IMP,DISTANCE), \quad (6)$$

where, again, ANR is the expected annual net return from production activities.

This equation (or another equation indication how ANR is affected by still other factors not listed) could form the basis for estimating how ranch characteristics affect annual earnings potential and, thus, ranch market value via equations 4 and 5.

Estimating QOL Market Influences

The QOL component of equation 5 might be defined as follows:

$$QOL(\mathbf{Z_q}) = QOL(DEEDAC,BLMAC,USFSAC,STATEAC,LOCATION_i,$$
$$IMP,DISTANCE,TIME), \quad (7)$$

where $\mathbf{Z_qB}$ represents ranch characteristics that affect amenity or QOL values. As alluded to in the Introduction, some of these characteristics might be unrelated to public land.

This would assume ranch buyers receive utility from owning or having access to more land. Other variables giving direct estimates of aesthetic appeal, like ranch elevation, scenic appeal, and recreational opportunities could be included if measurable at a reasonable cost. It is most likely, however, that region dummy variables ($LOCATION_i$) would have to be defined to indirectly capture aesthetic appeal based on broadly defined ranching areas with similar characteristics (Pope 1985, Torell and Bailey 2000). Explanatory variables defining finance terms, population density of the county, personal income levels, and the condition of the financial economy at the time of sale might also be expected to enter the QOL function. Estimating this function could be used to test

hypotheses about the significance of those factors, and thus, their relationship to QOL value.

Combining equations 6 and 7 into equation 5 (on page 28) provides an estimate of the total market value of the ranch. Market value would now depend on sources of forage for livestock production and sources of land purchased for aesthetic appeal. If statistical properties of the model were better by estimating on a dollar per AUM or AUY basis, dividing the equation by the total carrying capacity of the ranch (TOTAUY) would be appropriate. For example, if TOTAUY = (DEEDAUY + BLMAUY + USFSAUY + STATEAUY) then $/AUY return estimates from equation 6 become a function of the percent of carrying capacity coming from alternative land sources, plus other explanatory variables in the equation.

The marginal value of an AUY of forage could be estimated by differentiating equation 5 with respect to the amount of forage provided from a particular type of forage[9]. Consider the marginal value of a USFSAUY as an example:

$$\frac{\partial MV}{\partial USFSAUY} = \left(\frac{1}{i-g} \frac{\partial R_0}{\partial USFSAUY} + \frac{\partial QOL}{\partial USFSAC} \frac{\partial USFSAC}{\partial USFSAUY} \right). \qquad (8)$$

[9]An AUM is considered to be 1/12th that of an AUY so AUM values are easily estimated as well.

Table 2. Potential explanatory variables for hedonic ranch regression models.

Variable Name	Variable Description
DEEDAUY BLMAUY USFSAUY STATEAUY	Number of AUY provided from deeded, BLM, USFS, and State trust land sources.
HAY	Acres of hayland or perhaps tons of hay produced on the ranch. Further definition of type of hay produced may be required.
DEEDAC BLMAC USFSAC STATEAC	Number of acres purchased that are from deeded, BLM, USFS, and State trust land sources.
SIZE	Ranch size measured in acres or sections.
$LOCATION_i$	It is likely that not enough data will be available to estimate value individually for specific areas. Data could be measured across areas and dummy variables defined that identified ranch location to be in geographic area *i*. Standard definition would exclude one area and the location dummy variables would measure the difference in value for area *i* relative to the excluded area. The location dummy variable would capture geographic-specific differences in ranch characteristics.
IMP	House, building and capital improvement value on the ranch.
PROD	Average rangeland productivity of the ranch, defined as AUMs/acre, Acres/AUM, or perhaps AUY/Section.
DISTANCE	Distance in miles to a major trade center.
TIME	It is likely that not enough data will be available within a particular year to estimate ranch values during that year. Time of sale could be included as a trend variable or using dummy variables.

Equation 8 shows that marginal permit value would be estimated as the capitalized value of additional income generated from adding the unit of USFS grazing plus the marginal willingness to pay in the ranch real estate market for QOL values obtained by owning the permit. If the livestock raising experience were valued beyond the income earned, the added public forage itself would be valued for QOL reasons. As shown by Pope (1985) and Torell and Doll (1991), the inverse of the regression coefficient associated with the annual revenue function will provide an estimate of i-g, the rate at which annual income is capitalized into a ranch value.

It has been observed that in some cases ranchers are willing to lose money each year from the livestock enterprise, especially for small ranches. With very high QOL values exhibited in the ranch real estate market, the QOL component of equation 5 may more than offset income losses from livestock production. Higher grazing fees should theoretically decrease permit value through the impact on annual expected livestock returns, but depending on QOL values, grazing fees high enough to eliminate livestock income from the permit will not necessarily eliminate permit value.

Ranch Sales Data

Estimating hedonic ranch regression models requires detailed data defining ranch characteristics and terms of sale. Past studies in the western states have relied almost exclusively on data provided by Farm Credit Services appraisers. These appraisers routinely collect verified "comparable sales" information for market assessment.

Limitations of data needed to define ranch-level income earning potential can also be expected. First, it is likely that state-level cost and return estimates prepared by western universities or USDA-ERS will be too broadly defined to capture ranch specific

differences in earning potential. Detailed cost and return studies of specific ranches using FINPACK or SPA would provide an ideal, site-specific assessment of earning potential, but these detailed studies are limited, especially in the western states. The data collected is also confidential. Cost and return data of the detail collected by SPA and FINPACK can only be expected if implemented as part of a new study designed to collect ranch-specific income data for western ranches.

The data required to estimate hedonic ranch models must provide site-specific detail about the characteristics of individual ranches and terms of ranch sales. The availability of these data will likely depend on the goodwill and trust relationships established between rural appraisers and researchers involved in any potential valuation studies.

Contingent Valuation

The only application of CVM in valuing grazed forages was undertaken by Hof et al. (1989). They attempted to determine the willingness of ranchers to pay for or to sell federal forage. They elicited responses with forage priced on an AUM basis. Results were less than desirable, with ranchers apparently displaying a strategic behavior of not being willing to pay any more for the forage than the current federal grazing fee, nor willing to sell it for less than their next best alternative (i.e., the private lease rate). While Hof et al. (1989) concluded that CV was an inappropriate way to value public land forage, we feel that CV may still be a valuable methodology in examining the production and QOL values associated with public land grazing given recent advances in CVM and a new design of survey methods.

Many of the problems associated with CV can be rectified by appropriately defining the policy issue being addressed. Hof et al. (1989) showed that using the grazing fee as the payment vehicle created a strategic bias by respondents. Mitchell and Carson (1987) suggested that the payment vehicle must be both realistic and neutral. While the grazing fee is a realistic payment vehicle for federal forage, it is not neutral given the political controversy that has surrounded grazing fees. We propose that permit value be used as the payment vehicle. Federal land permittees have argued for decades that permit value is a legitimate cost of grazing on federal lands. Most ranchers purport that permits have value and have been willing to give an estimate of their worth. Detailing the question in terms of a willingness to pay for the grazing permit, as a one-time payment as opposed to an annual payment, may help reduce bias and a direct correlation to the annual grazing fee observed by Hof et al. (1989).

One of the problems associated with using permit value as the payment vehicle in a CVM study is asking the valuation question in a realistic manner. Grazing permits cannot be exchanged on the open market. They represent a right to graze federal forage and are tied to a base property such as deeded acreage, water rights, or livestock. Grazing permits are typically transferred to another owner when the base property changes hands. It is important to embed the valuation question in a setting that is both realistic and legal, but it is difficult to think of how one might pose a CV question in a WTA context. Grazing permits present a somewhat strange situation for CV. Ranchers and others recognize that permit values have been capitalized into land values, which implies a property right. In reality, though, there is no legal property right. The grazing permit is considered a privilege, and there is no legal obligation to compensate ranchers if

the terms of the permit are changed or it is withdrawn completely. While the proper survey design must be the subject of pre-testing, we feel the following scenarios contain ideas that merit further consideration.

1. Some economists have suggested that public lands be leased out for grazing by competitive bid. Many individuals feel that permit holders have a vested interest in, and have paid for their grazing permits. Hence, they should be compensated for their loss if a competitive bidding process were implemented. This would require a special act of Congress and would necessitate the federal government purchasing permits from the current users before implementing a competitive bid program. Suppose such legislation were considered. *What would be the minimum acceptable compensation for your permit on a dollar per AUM basis?*

2. From time to time, allotments become vacant and are available for purchase from the previous tenant, along with some base property, or are made available by the Forest Service. *If an allotment next to your property or to your allotment were to become available, what would you be willing to pay as a one time payment ($/AUM) for the perpetual right to graze the allotment and have the permit associated with your base property?* This question could be asked for varying numbers of AUMs.

3. Scientific advancements have been made in the area of range management. Some individuals are optimistic that science will improve the productive capabilities of Forest Service grazing allotments. The question would be: *If the USFS was able to make improvements that increased the carrying capacity of your permit, what would you be willing to pay per AUM for the perpetual right to use those extra AUMs and have the permit associated with your base property?*

Two of these questions deal with willingness to pay and one with willingness to accept or sell AUMs. Willingness to pay questions are typically used in contingent valuation studies because of the difficulty in obtaining valid willingness to accept compensation results when assessing nonuse values (Jakobsson and Dragun 1996). Individuals typically have difficulty accepting a compensation scenario when dealing with natural resource issues (Mitchell and Carson 1987). Empirical studies also have shown that willingness to accept values are typically 3 to 20 times more than those

obtained from willingness to pay questions (Jakobsson and Dragun 1996). Mitchell and Carson (1987) suggest that willingness to accept measures are appropriate if the agent has the right to sell the good in question. With most natural resource assets, the common citizen does not have a vested property right in the good being examined. Conversely, ranchers have been able to transfer grazing permits to others with the permit value being capitalized in the total value of the ranch. Testing the experimental design with appropriate focus groups should show if one measure provides better results.

We suggest that open-ended, trichotomous choice, and dissonance-minimizing formats be evaluated for survey instruments used in asking the valuation questions. An open-ended format allows respondents to state their WTP or WTA without being influenced by a starting bid (Bishop and Heberlein 1990). While this format may lead to strategic behavior, as respondents have the opportunity to declare payments much higher than they would actually pay in order to strategically bias the results, it may work well in a pretest to determine the optimal number and spacing of bids (Boyle et al. 1998) for the other elicitation methods suggested.

The dichotomous choice format presents an individual with a bid amount and asks them if they are willing to pay that amount. This format mimics an actual market in that the respondent is confronted with a take-it-or-leave-it proposition (Van Kooten and Bulte 2000). Strategic behavior is less likely to be employed using a dichotomous choice compared to an open-ended format, but the potential for "yea-saying" is increased. In practice, the bid amount varies from survey to survey, with the bid price levels and range of bids determined by pre-testing and optimization procedures (Boyle et al. 1998).

Yea-saying may be minimized by presenting a series of questions in a dissonance-minimizing (Blamey et al. 1999) or trichotomous choice (Loomis et al. 1999) format which allows the respondent to express support or opposition to a proposal without having to accept a bid price that is beyond the budget constraint. These formats may prove helpful in alleviating protest bids by ranchers given the potential sensitivity of the type of questions being asked.

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Updating Through Time

Because of the time and expense involved in conducting hedonic permit value or CV studies, it becomes imperative to update forage values between studies using some indexing procedure. Historically, private land lease prices have been used to update federal land forage values. At a minimum, we recommend the sample size be increased and the survey format be changed to elicit lease rates from only lessees or lessors of private forage, and that the ensuing forage value index be used to update federal forage values. Ideally, further study should be conducted to determine if other price series, such as an index that tracts asset or land values through time, would be a better indicator of forage value and QOL indicators.

Comparability to Other Values and Application in SPRA

Five resource outputs are considered in the Strategic Plan analysis: minerals, range forage, recreation (including fish and wildlife), timber, and water. Each of these resource outputs is valued both under the receipts and the total use value accounting stances discussed in the Introduction. Measuring receipts is simply an accounting of

existing fees and revenues from the various resource outputs. The more conceptually difficult issue concerns accounting for total use value. Preceding sections of this paper have described the conceptual basis of total use values estimated for range forage. It would be highly desirable for all resource outputs to be valued in a compatible conceptual framework, thus facilitating direct comparisons of alternative mixes of outputs. This section considers the conceptual bases underlying values estimated for other resource outputs.

For economic analyses, the correct approach to valuation is to value the marginal unit(s). Marginal value of a resource output is the value of the unit(s) of output that would be added (lost) if output were increased (decreased) by one unit. The problem lies essentially in whether one can identify the unit(s) being lost or added—do we know the value of the marginal unit? In a price-rationed situation, in which goods are rationed solely by price and which occurs in a competitive market, one knows that the value of units lost is the market price. In the case of a decrease in units, the price increases and those not willing to pay the new price drop out of the market and those are the marginal units. When units are added, the price drops and those additional people willing to pay the new lower price represent the new units of consumption. When goods are not rationed solely by price, one cannot really identify the marginal unit and so it is harder to know its value—the individual units lost might be high valued units or they might be low valued units. The best one can do is to use the statistical expected value (or average) of the value of all units of consumption, which is market price plus average consumer surplus, as the value of the marginal unit (Mumy and Hanke 1975, Hof and Loomis 1986). Another key concept in valuing the outputs of national forests and grasslands is

that under a competitive system, all values attributable to the resource are captured at the point of extraction, which has implications for estimating the value of each forest output.

Minerals

The 1990 RPA Program Analysis used market prices for mineral commodity outputs of the national forests that were derived from a study by the U.S. Bureau of Mines (U.S. Dept. of the Interior 1989a, 1989b). Energy prices were derived from Department of Energy data (U.S. Dept. of Energy 1987a, 1987b). Because minerals move in national and international markets, which are generally competitive in nature, market prices provide reasonable estimates of marginal value of the "finished" goods sold in the market. If National Forest System mineral output were increased or decreased, that change in unit transactions would occur at the market price. If the amount of output change were large enough, i.e., if the Forest Service output were large enough to substantially affect the market availability of a given mineral, some adjustment of market price might occur and the market would re-equilibrate at the new price. These market prices include additional production and processing value beyond the point of extraction. Thus, the market price of minerals from national forests and grasslands must be adjusted downward to value the raw minerals at the point of extraction.

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Market commodity prices were applied to the known reserves at each site on National Forest System land, and then operators' estimated expenditures to extract and mill the material (i.e., the production process to obtain a salable mineral) were subtracted. The resulting difference is an estimate of the mineral's value in the ground, the point of extraction, which in turn is an estimate of an operator's willingness to pay for the right of mineral extraction. This conceptual framework for mineral outputs is based on

neoclassical theory of the firm. The value is an estimate of what a firm would pay to obtain the mineral as an input to its production process.

Timber

Timber values are based on high-bid stumpage prices, which are the winning bids among the competitive bids received when a timber stand is offered for sale. Those bids represent the value of the standing timber, which is the point of extraction. The marginal units, at the level of a timber sale, are identifiable. If a given sale is made or not made, the marginal value of that timber added or lost is the high-bid stumpage price. The theoretical underpinning is, again, standard neoclassical theory of the firm. After a timber sale has been marked and cruised, bidders have knowledge of the quantity and quality of timber offered for sale. They also know their own production process (i.e., how much finished output can be produced from the given quantity of timber and how much that process costs). Finally, they know the price for which the finished output can be sold. Under a competitive bid system, bidders have an incentive to bid the full input value of the timber in their production process (the value of the marginal product), thereby bidding away producer surplus to maximize the chance of winning the bid (McCollum 2002). In a situation where the competitive process operates efficiently, one expects surplus values attributable to timber resource outputs to be zero. To the extent that there are imperfections in the competitive bidding process or the market, some level of surplus value accrues to timber operators and would be appropriately included in total use value. Such value would be in addition to the high-bid stumpage value, if it can be estimated.

Recreation

The conceptual framework in which recreation is viewed is not so unlike that for timber as one might imagine. Recreation is viewed in a household production framework in which individuals/households purchase a variety of goods and services (gasoline and other travel related items, food, camping equipment, fishing lures, etc.) and combine them with time and human capital to produce outdoor recreation experiences (Smith et al. 1983; Bockstael and McConnell 1981, 1983). A wide range of recreation activities occurs on public land, such as hiking, camping, consumptive and nonconsumptive uses of wildlife, among others. One critical input to all those activities is access to public land and, for our purposes, national forest land in particular. Access to recreation opportunities is the national forest output related to recreation.

Like firms, individuals know their production functions and marginal cost functions for producing outdoor recreation experiences. They also know or have an idea of how much benefit they receive from outdoor recreation experiences just as firms have an idea of the benefit (in the form of price/revenue) they receive from their finished output. When we look at how much people pay for national forest based recreation, and how much benefit they receive from those experiences, we are essentially looking at point estimates of marginal cost to produce units of outdoor recreation experiences and point estimates of the benefit received from those units of output.

A difference between recreation and timber (and minerals) is that we have no easily identifiable value of the marginal unit that would be added or lost if a recreation site opened or closed. We have no indicator akin to high-bid stumpage price, based on competitive bids, or market price. The recreation experiences that would be added or lost

could be very high valued ones or very low valued ones, but we cannot tell which. The best we can do is to take the average value of all the recreation experiences at the site and apply that value as the marginal value. The conceptual framework is the same as those for timber or minerals, the difference is the lack of ability to identify the value of the marginal unit. That difference withstanding, the marginal values are conceptually comparable.

Water

Water values in the 1990 RPA Program were estimated by Colby et al. (1988). Data from a review of the literature and from proprietary databases were combined with input from water resource managers to compile a database of more than 900 market purchases and leases of water rights in the western U.S. Information on water prices was reported in terms of raw (untreated and undelivered) water. Raw water price is the price of the water instream on the national forest—the point of extraction. When raw water prices were not available, values of water delivered to municipal, industrial, or agricultural users were used. Transportation and treatment costs were separated from those values to obtain the residual value of the raw water whenever possible. Long-run prices were used to the extent they were available. Short-run prices were only used as a second best measure. Because markets for water were just emerging at the time of the Colby et al. study, they did not always function smoothly and were only imperfectly competitive. Still, observed water transactions do provide useful information. Imperfect markets of this type often lead to transactions where the negotiated price falls somewhere between the buyer's maximum willingness to pay and sellers' minimum compensation demanded for the quantity of water transferred. Observed transactions prices were

supplemented with computations of residual values, development costs from similar projects, and estimates of least-cost alternatives.

The conceptual basis for the SPRA water value estimates is a competitive market. To the extent that water is price rationed, market price is a conceptually correct representation of the marginal value of that water. There are ongoing discussions about how to deal with water values in a manner comparable to other resource outputs (e.g., Brown 2000).

In the 1990 RPA Program, values were only attributed to additional waterflows stemming from management activities on National Forest System lands. Most of that additional flow was attributable to timber harvest. Because of reduced harvest levels and other factors, increased flows were not estimated for the Draft 1995 Program or the 2000 Strategic Plan.

Summary, Discussion, and Conclusions

Most of the studies to value forage account only for the value of agricultural production while neglecting the added value that comes from the QOL aspects of ranch ownership and forage use. Production analysis techniques, including linear programming and enterprise budgeting, by definition, consider only the productive aspects of public land grazing. Methods that compare to the private forage market, such as the total cost approach or market price comparison approach, adjust or account for differences in user costs between public and private forage grazing. QOL aspects are incorporated into the valuation only to the extent they exist in the private forage market, but private leases are typically short term and held mainly for productive purposes. Depending on the number

of bidders, a competitive bid system for grazing rights should elicit a bid that includes both production value and QOL values the forage lessor might attach to the lease.

A permit value approach should incorporate QOL aspects because the total amount ranchers are willing to pay for the right to graze public lands includes the cost of the grazing permit (some or all of which might be capitalized into the price of a given piece of land), annual non-fee grazing costs, and the expected annual grazing fee. This total expenditure is a demonstrated willingness to pay for public land forage, with the value of the grazing permit capturing any excess capitalized forage value that accrues for a variety of reasons. Those reasons could include excess livestock production value, economies of scale that accrue from the complementarities between public and private enterprises, QOL factors that influence the general land market, and utility the permit holder receives from having access to public lands.

Contingent valuation methods are designed and used to elicit an individual's willingness to pay for all aspects of a grazing lease, including quality of life values. That is one method that could be used to estimate permit values. However, the only study attempting to impute a value to public land grazing using CV resulted in survey responses apparently anchored on the federal grazing fee and the private lease rate. The survey was not able to account for QOL leasehold aspects in the evaluation, nor was it able to elicit what the researchers considered to be valid estimates of forage value and willingness to pay (Hof et al. 1989). While the flexibility of CV holds promise for estimating the value of a grazing permit, challenges remain in how to actually design a study to do so.

The hedonic method is another promising avenue to value grazing on public land. Theoretically, all aspects of a piece of land on which buyers place value will be

capitalized into the market value of the land, or access to the land. This includes aspects related to livestock production and those related to QOL. Challenges exist as to how to define and express the dependent variable in the hedonic model valuation, when a large part of the carrying capacity of the ranch is from public lands. Further, and perhaps more challenging, estimating what part of ranch value and permit value comes from future earning potential and what part from QOL factors requires separation of the market value into basic components of value.

Several studies have attempted to incorporate QOL factors into hedonic ranch value models. While progress has been made toward understanding the interactions and effects of different factors, clear and generalizable results remain elusive. Adequate data are lacking about how earnings potential and aesthetic values differ between ranches. An earlier section of this paper outlined an hedonic ranch value model that we think will advance understanding of QOL factors of ranch and grazing land values.

The Strategic Plan analysis is descriptive. Under the total use value accounting stance, its purpose is to describe and account for benefits received by users of the outputs from national forests and grasslands, regardless of whether those benefits are captured in market or market-like transactions. Total use values are appropriately measured in a competitive market. Where competitive markets exist for the outputs of national forests, market prices represent marginal values and can be used to calculate total use value. In cases where competitive markets do not operate efficiently, most notably recreation and the QOL component of grazing use, one needs to go beyond the concept of market price. In those cases, consumer surplus needs to be considered so market price plus average

consumer surplus, or total willingness to pay, is the theoretically appropriate measure of total use value.

All the forest outputs are valued in the context of neoclassical theory of the firm. The conceptual basis for water, timber, and mineral values is the competitive market. Those outputs are appropriately valued at the market price. Demand for those outputs may or may not be perfectly elastic (i.e., the demand curves may not be flat). Where it is not, some surplus value exists and should be counted in total use value. One indicator of whether demand is perfectly elastic is the extent to which the output of national forests and grasslands is substantial enough to affect market price of that commodity. If it is, then the demand is not perfectly elastic from the Forest Service perspective. The shape of the demand curve is an empirical question that needs to be examined.

Recreation access is a nonmarket, frequently unpriced, good and is not rationed solely by price.[10] The grazing output of national forests and grasslands could have a significant QOL component. For those two outputs especially, one needs to look beyond the market price analogy and include surplus value. Nonetheless, total use value is what is being measured in all cases. Because all the outputs from national forests are valued in a way appropriate to measuring total use value, the values are conceptually comparable.

Considerable confusion has resulted from some economists declaring recreation to be a final demand good and timber, grazing, minerals, and water to be intermediate goods. That difference, it is claimed, makes comparisons between recreation and the other inputs invalid. The fact is they can be compared, and it is appropriate to do so. The distinction between final demand and intermediate goods is not a helpful dichotomy for

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[10] With the advent and spread of fees for recreation on public land there is beginning to be an element of price rationing. Whether the fees are high enough to effectively ration use is debatable.

valuing outputs from the National Forest System. The issue is not whether particular goods are consumer goods or intermediate inputs to industrial processes. The issue is how National Forest System resource outputs are used directly and immediately. In all cases, the output of the national forest or grassland is combined with other inputs to produce some other good or experience.

Further evidence of comparability comes from where the forest outputs are valued. Standing timber, raw water instream on the forest, minerals in the ground, and access to the national forest in the case of grazing and recreation are all captured on the forest, where the output is delivered. With an appropriate valuation, all resource outputs will be valued at the point of extraction, and all will be valued in a conceptually comparable context.

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